University of Alberta

What is the effect of information and computing technology on healthcare?

by

Dave Ludwick

A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
in
Engineering Management

Department of Mechanical Engineering

Fall, 2009
Edmonton, Alberta

Examining Committee

Dr. John Doucette, Department of Mechanical Engineering, University of Alberta

Dr. Peter Flynn, Department of Mechanical Engineering, University of Alberta

Dr. Pierre Mertiny, Department of Mechanical Engineering, University of Alberta

Dr. Jason Carey, Department of Mechanical Engineering, University of Alberta

Dr. Don Philippon, School of Public Health, University of Alberta

Dr. Andre Kushniruk, School of Health Information Science, University of Victoria

Abstract

Long waitlists and growing numbers of unattached patients are indicative of a Canadian healthcare system which is unable to address the demands of a growing and aging population. Health information technology is one solution offering respite, but brings its own issues. Health information technology includes primary care physician office systems, telehealth and jurisdictional EHRs integrated through interoperability standards to share data across care providers. This dissertation explores effects that health information technology has on primary care. Literature reviews provided context of health information systems adoption. Surveys and semi-structured interviews gathered information from health system actors. Workflow analysis illustrated how technology could change physician office workflow. Exam room observations illustrated how technology affects proxemics and haptics in the patient encounter.

This research derived change management models which quantified substantial change management costs related to adoption of physician office systems. We found that physicians have concerns over how health information technology will affect efficiency, financial, quality, liability, safety and other factors. Physicians in smaller suburban physician offices take little time to select a system for their needs. Urban, academic and hospital physicians spend more time networking with colleagues and devote funds to project management and training. Our studies showed that stronger professional networks, more complete training, a managed approach to implementation and in-house technical support are more influential in facilitating adoption than remuneration models. Telemedicine can improve quality of care, the referral process for family physicians and access to services for patients. Teledermatology was shown to make significant improvements in access to services for patients, but referring physicians are concerned about their liability if they follow the recommendations of a dermatologist who has not seen their patient face-to-face. Certification organizations mitigate liability, procurement and financial risk to qualifying family physicians by pre-qualifying vendor solutions, coaching physicians

through procurement and reimbursing family physicians for purchasing an approved system. We found that centralization plays a key role in adoption of health information systems at the jurisdictional and primary care level. Online scheduling can reduce human resource requirements used in scheduling, if the system is well implemented, well documented and easy to use.

Acknowledgements

My first, and most earnest, acknowledgment must go to my advisor, Dr. John Doucette. Four years ago, a brief conversation with Dr. Doucette started me on the path I traveled at the University of Alberta. Dr. Doucette has successfully guided me through the experience of academic study and research. Many times, I have tried his patience and, as many times, he has come back with helpful direction and advice, leaving me room to make the decisions I needed to make. Thanks, John, for the investment you made in me.

Far too many people at Alberta Health and Wellness have assisted in so many ways during this work. Gordon Lucas, Freda Ainley, Stewart Ingram, Lloyd Thorpe, Bela Berci, Dennis Hulme, Fran Shields, Steve Shields, Seema Sharma, Linda Miller, Mark Brisson and so many others answered my questions during my early days in the health sector. They all have my sincere gratitude. I would also like to thank my instructors, Dr. Denis Protti, Dr. Don Philippon, Dr. Nicola Shaw, Dr. Ted Heidrick, and Dr. Sandra Jarvis-Selinger for handling my exuberance so eloquently.

Let me take this opportunity to thank my co-authors for helping me deliver such a prolific list of academic publications, presentations and posters. You had to deal with my unacceptable timelines, relentless edits and all-around pushiness.

Let me thank the physicians of the Sherwood Park PCN, specifically Dr. Jim Adams, Dr. Sean Cahill, and Dr. Moiz Ramji. Your friendship and support in these studies is greatly appreciated. Thank you to the staff from the Sherwood Park PCN for being willing participants in this experiment. Thank you to Dr. Donna Manca for your help and support in our paper together – you taught me much about qualitative research. Dr. Nicola Shaw, thank you for your words of wisdom and knowledge in the area of research methodology.

I must make a special note of thanks to Dr. Peter Flynn. Dr. Flynn, you took the time on that very first day to talk to me about my PhD interests. Later, you cast a vote of confidence in me by allowing me to teach your course and then stood by me as I developed into a competent instructor. Thank you for introducing me to John.

Of course, a penultimate thank-you goes to my wonderful parents, Roger and Lois Ludwick. For always being there when I needed them most and for allowing me to believe I could do anything.

My final, and most heartfelt, acknowledgment must go to my wife Tracy. Tracy, you had to endure the endless nights of research, reading, studying, and complaining. Your support, encouragement, and companionship have turned my journey through graduate school into a pleasure. For all that, and for being everything I am not, you have my everlasting love.

Glory to God.

Table of Contents

List of Tables

List of Figures

List of Equations

List of Abbreviations

ADE – Adverse Drug Events
AHS – Alberta Health Services
AHW – Alberta Health and Wellness
AIX – Advanced Interactive eXecutive (IBM's Unix implementation)
AMA – Alberta Medical Association
ARP – Alternative Relationship Plan
ASP – Application Service Provider
CAB – Change Advisory Board
CAP-GP – UK Common Assurance Program for GP Systems
CCHIT – Certification Commission for Health Information Technology
CDS – Clinical Decision Support
COTS – Commercial Off The Shelf
CPG – Clinical Practice Guideline
CPOE – Computer Physician Order Entry, Computer Provider Order Entry
CPU – Central Processing Unit
DICOM – Digital Imaging and Communications in Medicine
DITR – Diagnostic imagining text reports
EDIFACT – Electronic Data Interchange For Administration
EHR – Electronic Health Record
EMR – Electronic Medical Record
FFS – Fee-For-Service
FHG – Family Health Group
FHT – Family Health Team
FP – Family Physician
GP – General Practitioner
GPSoC – UK GP Systems of Choice
HIA – Health Information Act
HIAL – Health Information Access Layer
HIE – Health Information Exchange
HIT – Health Information Technology
HL7 – Health Level 7
HTML – Hypertext Markup Language
IHN – Integrated Health Network
IJMI – International Journal of Medical Informatics
IJTA – International Journal of Telemedicine and Applications
IOM – US Institute of Medicine
ITIL – Information Technology Infrastructure Library
itSMF – Information Technology Service Management Forum
LOINC – Logical Observation Identifiers Names and Codes
LTC – Long Term Care
MOHLTC – Ontario Ministry of Health and Long Term Care
MSA – Master Service Agreement
NEHTA – Australia National E-Health Transition Authority

NHS – UK National Health Service
NP – Nurse Practitioner
OECD – Organisation for Economic Co-operation and Development
OHCP – Other health care provider
P4P – Pay For Performance
PCN – Primary Care Network
PCP – Primary Care Physician, Primary Care Provider
PCT – Primary Care Trust
PHCTF – Primary Health Care Transition Fund
PHN – Personal Health Number
PHO – Primary Healthcare Organization
PHR – Patient Health Record
PIA – Privacy Impact Assessment
PITO – British Columbia Physician Information Technology Office
POSP – Alberta Physician Office System Program
QBIF – Quality Based Incentive Funding
QOF – Quality and Outcomes Framework
RAM – Random Access Memory
RFP – Request For Proposal
RHA – Regional Health Authority
RT – Real Time telehealth
SCHIP – State Children's Health Insurance Program
SEF – Scottish Enhanced Functionality
SF – Store and Forward telehealth
SMA – Saskatchewan Medical Association
SNOMED – Systematized Nomenclature of Medicine
SOA – Service Oriented Architecture
SQL – Structured Query Language
SSO – Single Sign-On
TCP/IP – Transmission Control Protocol/Internet Protocol
UAT – User Acceptance Test
VPN – Virtual Private Network

Chapter 1 – Introduction

1.1 The Case for Health Information Technology

Computing technology has already left its mark on healthcare. The diagnostic equipment available today provides physicians with so much information that new specialties are regularly developed to make sense of it. Technology allows physicians to look inside the body without harming it. Computer networks support quality care to patients anytime and anywhere. Still, Health Information Technology (HIT) remains in its adolescence. Even though information management systems have existed in other industries for decades, HIT is still not ubiquitous in healthcare.

Certainly, there is a growing business case for the urgent adoption of HIT. The aging Canadian population is well documented as is its intensifying requirement for healthcare services. Demand for primary care is also driven by the growing incidence of obesity, not just in adults, but in children too. Obesity is, at least, correlated to chronic diseases. Chronic diseases require ongoing management, usually carried out at the primary care level of the healthcare system. Unfortunately, the escalating demand for care is not being matched by its supply. Just as patient populations are aging, so too are their family physicians. There are fewer family physicians joining the healthcare system as replacements, fewer are choosing primary care as their career and more women (who sometimes work fewer hours so they can take care of their families) are entering into primary care, reducing the overall number of hours available to provide care.

There are several strategies being implemented to address the supply and demand gap at the primary care level. Primary Care Reform strategies include disease prevention, health promotion, use of interdisciplinary teams in care delivery, integrated and coordinated care as well as the use of HIT. The naive engineer hypothesizes that widespread adoption of HIT should be effortless. After all, information management systems have infiltrated other professions such as accounting, law, and engineering. Is there any reason why the medical profession should be any different? Soon the unsuspecting engineer realizes the unique challenges of implementing HIT in an effective manner. There are a number of unanticipated confounding factors that complicate the adoption of HIT. Privacy, patient safety, workflow and job security implications for staff, time required to implement systems, time required to learn systems, quality of care, financial implications, efficiency, and liability concerns are facets which require special consideration if HIT is to be an effective tool in healthcare delivery. More than accounting, law or engineering, the healthcare industry is uniquely the one where life, or at least quality of life, hangs in the balance of product or service outcomes.

1.2 Problem Statement

What, then, is the effect of information and computing technology on healthcare? How does the adoption of HIT affect the delivery of healthcare in Alberta's primary care health system? The purpose of this dissertation, and the studies that have preceded it, is to determine the factors, drivers, influencers and confounders of HIT adoption and to answer the research question "What is the effect of information and computing technology on healthcare?". To answer this main research question, several supporting questions were used to guide the selection of courses and research:

- How does physician liability affect the adoption of health information technology? Do physician office system certification organizations mitigate the liability risk to physicians?
- Do general practice remuneration and health information systems funding combine to facilitate adoption of physician office systems?
- Does telemedicine facilitate peer review and second opinion in primary care? How does telemedicine affect the referral process to specialists? Does telemedicine facilitate access to specialist services for patients?

1.3 Hypotheses

The author formed several hypotheses in preparation for the work described in the following dissertation:

- We hypothesized that the physician office systems brought inherent value in efficiency that physicians would readily embrace.
- We hypothesized that health information technology would assist physicians in mitigating their liability. However, as will be discussed below, physicians' lack of familiarity with health information systems caused them to interpret that they would bear more liability risk rather than mitigate it.
- We could not initially appreciate how certification organizations could facilitate physician office system adoption and so hypothesized this to be the case.
- We had great expectations that adoption was significantly affected by the way in which family physicians are remunerated. Physicians paid via a fee-for-service pay method do not have the time to adopt health information technology.
- The author hypothesized that telemedicine would facilitate quality assurance in primary care by facilitating specialist referral.
- We hypothesized that physicians will leverage health information technology to develop practice efficiencies once physicians have adopted health information technology and integrated it into their practice. We hypothesized that physician offices could improve office efficiency and be more accessible to patients by adopting online self-service appointment scheduling systems.

1.4 Expected Outcomes

We expected that physician offices have well-established physician office practices with established workflow processes. We expected that staff and physicians would welcome information management technology and that integration would be immediate and seamless. We expected that physicians (practicing in many care settings), being prudent professionals, would avail themselves of the tools, funding and services that will help them match the best technology solution to their practice needs.

We expected that physicians, again, being prudent professionals, would take their time to select and implement the best product for the information management needs. They would choose to hire an information technology consultant to assist them with installation and training. We expected that, once implemented, physician office system solutions would improve office efficiency resulting in an increase in the number of patients a physician could see in the long run.

Online patient self-service appointment scheduling is an example of long term efficiency. We expected that physicians would see an opportunity to save on overhead costs by replacing, or reducing, receptionist services with automated self-service appointment scheduling. Like any technology, we expected that the upfront costs of online systems would be paid back through cost savings over time. We thought that some patients, such as seniors, would not be able to use or have access to the systems needed for online booking and we anticipated that some may choose to continue to book by phone. We believed that many patients would appreciate the opportunity to make a call to book appointments when it is convenient for them.

We expected that telemedicine technology could facilitate quality assurance, facilitate specialist referral and increase access to specialist services for patients. We did not expect referring physicians to have concerns with referring patients to a local clinic facilitated by telemedicine if the care pathway reduced wait times for patients.

We had no expectation that using telemedicine technology to facilitate referral would impact physician liability positively or negatively. Physician office system certification programs claimed to mitigate physician liability, procurement and financial risk when purchasing health information systems, but we did not anticipate that such organizations could mitigate liability.

1.5 Scope and Context

The dissertation and the supporting body of work described below constitute a program of PhD study. Articles examined the effects of information and computing technology adoption in Alberta primary care. Healthcare, of course, is an extremely large industry and so the focus of these studies was the adoption of HIT in the primary care sector. Primary care was the focus of these studies because it is here where a great amount of systemic change is underway. Primary care is the place where most people engage the healthcare system for their everyday health needs. The author has had the great opportunity to work as a leader in a primary care organization and to drive the changes implemented there.

Information and computing technology can refer to a wide range of topics within computing such as networks, hardware and various other systems. This dissertation examines the adoption of health information management systems, referred to as health information technology, which is used to manage the health information of patients in primary care physician offices. This program examines the tenuous adoption period during which physician offices choose to adopt the technology all the way through to its integration into physician office operations. A small study at the end of the dissertation illustrates additional benefits that an HIT system offers a physician office once fully integrated.

Although the focus of the studies is on information management systems in primary care, it is necessary to consider other types of information technology from other care settings such as physician order entry systems, pharmacy systems, and hospital admissions systems to complete the study. To support the understanding of HIT adoption in Alberta's primary care system, this author, as primary researcher, undertook broad studies designed to gather information from other jurisdictions and other domains of care. Healthcare policy is often a national, public agenda, and therefore the studies detailed below took an international view to provide the perspective needed to evaluate and inform HIT adoption here in Alberta. The dissertation provides comparison with the United States because of the proximity of the two countries. The technology adoption experience in other domains of care was also studied because that adoption experience could inform the understanding of technology adoption in primary care. Although our focus is to understand the adoption of HIT in family practice, we examined the adoption of electronic health records (health information systems that manage patient health information across a whole jurisdiction) because we believed that the technology adoption experience at the jurisdictional level informs and affects the adoption experiences at the staff level in a physician office.

Without diminishing the role of other contributors, the author of this thesis (a PhD student) played the leading role in developing the research questions, study designs, research methodology as well as in the study execution, data gathering, analysis and report writing processes. Co-authors contributed to these studies by reviewing study designs, data analysis and manuscripts. The author acknowledges and thanks his co-investigators for their valuable contribution in these studies.

1.6 Methodology

This PhD program of study started with participation in several courses to inform the author's knowledge of healthcare related topics. Courses, seminars and self-directed study reviewing the topics of healthcare technology, healthcare systems, healthcare policy, intellectual property, ethics and research methods formed the foundation of this work. Course deliverables were used as opportunities to dissect issues in HIT adoption and to occasionally report detailed findings in scholarly publications. Experimentation with different forms of research was used to develop knowledge of research methods. Literature searches, interview-based investigations, statistics, sampling and other research methods were practiced. Papers were designed to answer interrelated questions which supported the research questions. The studies afforded the opportunity to confront different healthcare system participants (physicians, specialists, patients and payers) to understand technology's influence from their point of view. The research afforded the opportunity to work with many different co-authors to practice scholarly writing and research as well as to learn from others' research experience. Several conferences and seminars offered the opportunity to deliver speech and poster presentations, where the ideas presented in this dissertation were tested and defended with other experts in the field.

1.7 Document Structure

The Background section describes a number of relevant concepts which, collectively, describe the environment into which HIT is inserted. Brief descriptions of healthcare financing, primary care reform, physician office operations and various forms of HIT are provided for context. The Methods section describes the approach taken to gather information for the program of studies, but also details the approach taken in the individual studies which inform this dissertation. The main body of this dissertation provides an integrative analysis of factors which affect or are affected by HIT adoption, answering the research question: "What is the effect of information and computing technology on healthcare?". Chapter 4 examines how HIT changes the culture and workflow of healthcare organizations and explores how these socio-technical conflicts can compromise HIT adoption. Implementation approaches, implementation risks, human factors in physician-patient communication, financial considerations and the implications of adoption for quality of care are examined in detail. Chapter 5 compares the experience of implementing jurisdictional electronic health records with the experience of implementing electronic medical records in physician offices. New responsibilities accrue to healthcare organizations when they commit to delivering a provincial electronic health information system. Physician offices take on further responsibilities when they adopt physician office systems. Certification organizations help manage the risks of adoption for both levels of the health system. Chapter 6 examines how HIT can facilitate improvements in physician office efficiency. Advanced access suggests that proper assignment of physician office tasks can help to match physician office supply to patient demand. HIT can facilitate efficient use of office resources by including the patient in the healthcare delivery process. Chapter 6 illustrates how a self-service appointment scheduling system supports the reallocation of administrative resources to help make the physician office run more efficiently, thereby increasing its capacity to address demand for care. Chapter 7 takes an in-depth look at how HIT adoption changes the role of physicians. Adoption requires physicians to step into the roles of project leader, procurement manager, network administrator, privacy officer, process analyst and even software designer. Chapter 8 concludes the discussion by answering the research question, critically reviewing the work presented in this dissertation and recommending future studies.

Chapter 2 – Background

2.1 Healthcare Supply and Demand

Many societal and healthcare industry factors are creating a gap between patients' rising demand for primary care and physicians' capacity to supply it. Two of these factors, both prevalent in primary care, are obesity and the aging population. Canada's population, like many western countries is rapidly aging. In the next ten years, the number of Canadians over 55 will rise from 22% to 32% [1]. By 2041, 22% will be over 65 [2]. As people get older, bodily systems deteriorate resulting in an increased need for healthcare [3]. It should be no surprise that per capita spending on health is almost 5 times greater for those over 65 than for those who are younger [4, 5]. In 2000, $97.7 billion was spent on healthcare for those over 65 who only made up 12.5% of the population [6]. In 2006, Canada's health expenditures rose to 10.5% of the national gross domestic product [5], higher than the 8.9% average in other Organisation for Economic Co-operation and Development (OECD) countries [7, 8]. The American situation is similar [9]. By 2020, healthcare spending in the US will rise to 21% of the national GDP [10]. A similar situation is seen in the Canadian context. Health expenditures will rise from 31% to 42% of total provincial and territorial governments' revenues by 2020 [1, 6]. By 2026, seniors are expected to make up 21% of the population and consume a staggering 60% of healthcare expenditures [6].

Demand for primary care is not just driven by aging, but also by the growing incidence of obesity. Adult obesity is not the only concern; obesity is growing in children too [11, 12, 13]. In 2004, 6.8 million Canadians aged 20 to 64 were overweight and another 4.5 million were obese [11, 14]. By 2007, this number had grown substantially to 8 million or 32% overweight Canadians [15]. Although not directly linked as a cause, obesity, the result of a culture of convenience, is at least correlated to several morbidities, including chronic diseases [16]. Chronic disease management is an ongoing responsibility for the family physician and their patient.

The increasing demand for care must be met with a greater supply. However, care providers are aging too. In the 3 short years between 2004 and 2007, 45 year old family physicians rose from 61% to 65% of the physician population [6, 17]. During the same period, 55 year old physicians rose from 30% to almost 33% of the population [18]. Physicians aged 21 to 35 declined from 21.6% to 10.5% of the physician population between 1985 and 2005, whereas the proportion of 55 to 64 year old physicians increased from 18.1% to 21.0%. Canada's health workforce is aging and retiring earlier and the average age of the remaining population is increasing [17, 19]. Retirements have risen steadily over the past decades, from 300 in 1981 to more than 800 in 2000 [20], corresponding to a retirement rate of 1.2% in 2000 which was expected to reach 3.1% by 2006 [21]. This, in part, has caused the density of practicing doctors in Canada to stabilize near 2.1 per 1000 people over the last 20 years when the average OECD physician population has risen to 2.9 per 1000 people [22]. No wonder, in 2007, 15% of Canadians aged 12 or older reported that they did not have a regular medical doctor [15].

Not only is Canada undersupplied with family physicians compared to OECD countries, but "the number of available spaces [in family medicine] has exceeded the number of candidates specifying this as their first preference for many years" [19]. A shortfall in medical school enrollments is expected because of increased training requirements, higher average tuition fees [23], and increasing certification requirements due to more health professions being regulated [19]. Alberta hasn't been able to meet the targets it set out to increase physician patient ratios, which currently hovers below 1 physician per 1000 people [24]. Trends in the generational mix add further downward pressure on healthcare supply. Older physicians are narrowing their practice scope [23] and younger physicians are working fewer hours [19]. Although female physicians currently represent only 30% of the physician workforce [22], the share of female medical school enrollees is becoming higher (58% of all enrollments in 2006/07 compared to 42.8% in 1986/87 and 14.3% in 1968/69) [22]. Female physicians are more likely to take time off for family and are less likely to work overtime [19, 24]. Considering the long hours of their predominantly male predecessors, a noticeable drop in the hours of service from young physicians can be expected.

The mismatch between soaring healthcare demand and eroding healthcare supply produces waitlists. Often, people who can't see a healthcare clinician resort to walk-in clinics or emergency rooms [15]. Of course, this is not just a Canadian phenomenon. In the past, as much as 40% of American emergency department visits were not urgent [25, 26]. Waiting too long may worsen patients' health [27]. Long waits also affect the performance of the healthcare system. When too many people wait, extra costs are sometimes incurred from managing the waitlist [27]. Waitlists in primary care cause patients to leave the queue and seek care through alternative channels, which adds to the cost since it is often most cost effective (from a health system perspective) if physicians see their own patients [28]. Many OECD countries have made waitlist management a significant publicly funded agenda [29]. In Canada, the federal government created the $5.5-billion Wait Times Reduction Fund to reduce wait-times [30]. Ontario unveiled a $2.1 billion strategy to improve workflow, improve safety, cut wait times and give diabetic patients an electronic health record by 2012 [31].

2.2 Healthcare Systems

2.2.1 Financing

Healthcare is a public agenda for many countries. Healthcare funding often comes from taxation in national or secondary levels of government (provincial/territorial/state/region/county/municipality). Where the national government collects tax dollars and where care is delivered from secondary levels, transfer payments or grants are paid to secondary governments to finance healthcare delivery [32, 33, 34, 35]. The amount of funding is based on objective criteria such as population, socio-economic status, health status or geographic location [33, 36]. Additional healthcare dollars are sometimes collected by secondary governments or care providers to supplement or complement the funding provided through public channels. Co-payments, private health insurance premiums, public health insurance premiums or other user charges [32, 34, 37] provide financial support for the health system but also serve as a method to motivate desired behaviours in the health consumer. In Canada, healthcare is devolved to the 13 provincial and territorial governments. Although each provincial health ministry must provide medically necessary services within the confines of the Canada Health Act, each government can take some liberties to design a health system to best meet the needs of their constituents.

Figure 2-1 below summarizes the funding mechanisms of the Canadian healthcare system (which varies from province to province and territory). The highlight of Figure 2-1 is the bottom right hand box that illustrates the relationships within the public system. Two orange boxes at the bottom of this section illustrate patient entry points for the public health system. Patients ideally enter the healthcare system by visiting their primary care provider. In cases where access to the family physician is not timely, they visit an emergency room. From there, patients may be transferred to other care services in the system. The mode of transfer implies different responsibilities for the next service involved in care delivery. For example, family physicians might consult other health care providers (OHCPs) to get a second opinion on a complaint. The consultation does not imply a transfer of care responsibility to the OHCP. Rather, the OHCP provides an opinion to the family physician, who has the choice to follow the direction implied by the opinion. During the consultation, the family physician remains in control of the continuity of care. Alternatively, the family physician may wish to refer the patient to a specialist for specialty treatment. A referral constitutes a formal transfer of care to the specialist, who then takes over delivery for that specific episode of care. Once complete, the specialist reports results back to the family physician, returning the patient to the family physician for continued general care. In this way, family physicians exert an immense, but distributed, amount of control in the health system by guiding and navigating the health system on behalf of their patients.

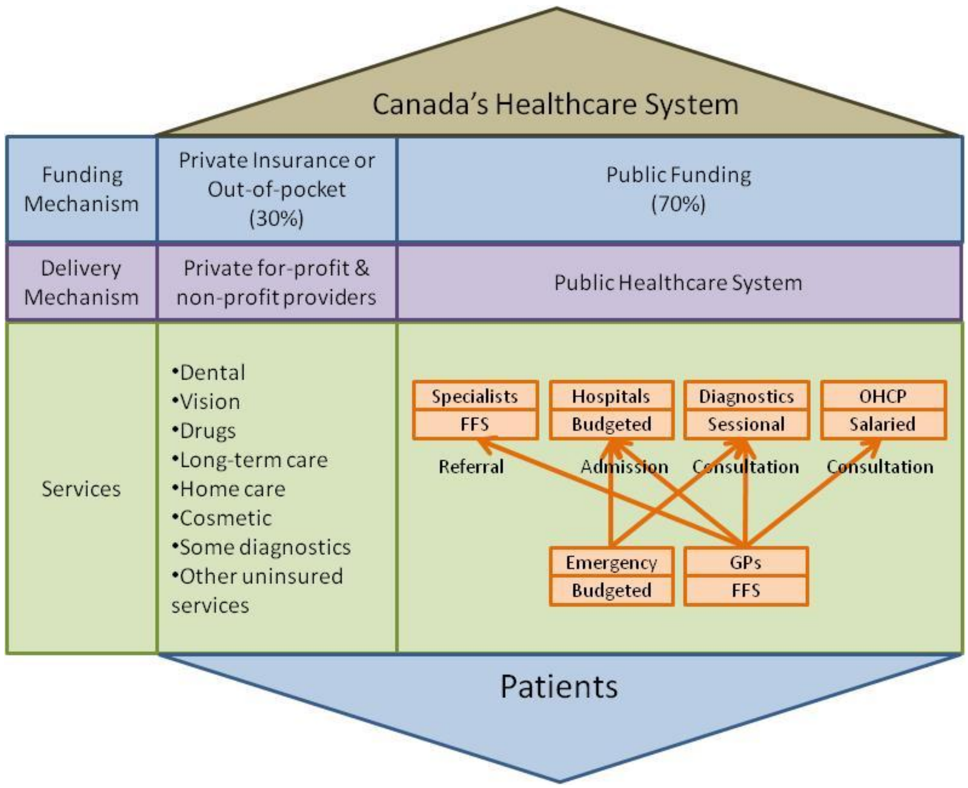

Figure 2-1: Canada's Healthcare System

In many countries, the public purse provides access to primary care physicians [33, 34, 35, 38, 39, 40], specialty care [33, 34, 35, 38, 39, 40], hospital care [33, 34, 38, 41], emergency services [33, 34, 38, 39, 41], psychiatry [34, 35, 38], and palliative care [33, 39]. This system design places the jurisdictional government in the role of the single payer for these insured services (access to long-term nursing home care, dentists, physiotherapists, pharmaceuticals and other non-medically-necessary services are often paid through a mix of public reimbursement, co-payments or private insurance). The one country which diverges significantly from the single payer model is the United States. Its proximity to Canada, the comparable decentralized models and the ongoing debate for a privatized Canadian healthcare model warrants a brief review of the American health system. Americans spend more time in the presence of their family physician than other countries [42]. The American health system is a multi-payer mix of for-profit and non-profit private healthcare delivery organizations financed by non-profit, for-profit and government administered insurance organizations [43]. American hospitals are owned by private for-profit and non-profit organizations as part of a private health system. There are hundreds of individual health systems which include primary care offices, specialty services, hospitals, emergency rooms, diagnostic services and all of the other components needed to run a health system.

For people under age 65 (262.6 million people in 2007), healthcare insurance is often provided as an employment benefit. In 2007, 61% of the non-elderly population was insured through employer-sponsored programs [44, 45]. Employers select the insurance companies and the insurance benefits [46] creating an employment package to attract high quality employees to their company. However, these selections are not always the best match for all employee needs. Employers will often cap their contribution to health costs to control their overall labour expenses [46] (which, nationally, currently sits at an average of 10.7% of payroll [47]). This leaves some of the expense for healthcare directly in the hands of the employee. Rising healthcare costs, insurance premiums, out-of-pocket healthcare costs and narrowing health plan coverage are making healthcare more difficult for insured workers to afford [48, 49]. In fact, roughly one third of those who work for organizations with fewer than 25 employees are uninsured [50]. “The allocation of labour in the economy is distorted by productivity-killing job lock, as employees spurn jobs in these smaller companies, which create about 80 percent of new jobs” [50]. Compared to a single payer system like Canada, the costs of the US healthcare system are enormous. In 2005, expenditures were twice as high in the US as in Canada (US$6697 per person compared to US$3326 in Canada) [51] which still left a substantial portion of the population without any health coverage at all (18% or over 50 million Americans were uninsured) [44, 45, 47, 52] as well as a substantial portion of underinsured people [53]. Some of this systemic cost comes from high overhead costs that are duplicated in insurance companies [54, 55]. Other costs include higher administrative costs, higher physician pay, higher drug costs, higher profits for private healthcare organizations, as well as, more cost due to heavy reliance on for-profit providers and insurers [49].

In addition to the many private health systems, the US has four government run health insurance programs which have some characteristics of single payers (at least for their specific beneficiaries). Medicare is the single payer, government administered health insurance program for the elderly and disabled. The program is financed by federal income tax and covers hospital services, physician services and drugs [56] for seniors. Medicaid is a state administered insurance program, funded by state and federal taxes, for the very poor under age 65. Wealth is not the only measure of eligibility. Gender, pregnancy, assets and disability also factor in [57]. The State Children's Health Insurance Program (SCHIP) provides health insurance coverage for children whose families are too wealthy for Medicaid but too poor to acquire private health insurance. It too is financed by state and federal taxes with premiums made available to eligible beneficiaries [43, 58]. The Veterans Administration is a federally administered, tax funded, single payer program for health insurance for US veterans [59].

Insurance is a common way of financing healthcare. The countries studied here all possess some form of insurance. Health insurance is a method of distributing the financial risk associated with variation in individuals' healthcare expenditures. Insurance works by pooling healthcare costs and distributing them in various ways. Insurance distributes costs over time (through the periodic payment of premiums), risks (through premiums paid by healthy and unhealthy people) and individuals [40] so that the total burden of healthcare is not excessively borne by any one individual or organization. Public insurance consists of premiums paid out of tax dollars to a pool held by the government (single payer) which is then used to finance healthcare delivery to constituents. In Canada, roughly 70% of healthcare delivery is financed through public healthcare programs [40]. Private insurance occurs when individuals pay a private company to provide healthcare coverage. Premiums, paid on a periodic basis, are pooled by the insurer to cover healthcare costs of its members. Both the public and private financing mechanisms involve prepayment of premiums from a wide range of individuals (healthy and unwell) to create pooled funds in advance of receiving care. Other models also exist. In their simplest form, medical savings accounts are like bank savings accounts. Individuals prepay into medical savings accounts and draw on those funds to finance their healthcare costs. Medical savings accounts are owned by individuals. Thus, these accounts do not pool premiums across individuals or risk; only over time. Medical savings accounts tend to reduce public healthcare expenditure by transferring some of the financing responsibility to individuals [60]. Out-of-pocket expenses are made by individuals at the time of care. Out-of-pocket expenses do not pool premiums over time, risk or individuals.

Jurisdictions design their public and private health insurance programs to provide a portfolio of financing options. Jurisdictions employ a mix of duplicate, complementary and supplementary private insurance to drive desired consumer behaviour. Duplicate coverage is private insurance that offers coverage for health services already included under public insurance. It may offer access to different providers or levels of service [40], not accessible from the public system. In Canada, duplicate coverage is prohibited for all publicly funded, medically necessary care. Other countries incent patients to purchase private health insurance for various points in the health system [40]. Complementary coverage is private insurance that provides coverage for residual costs from publicly funded health services (portions not covered or only partially covered by public insurance) [40]. Health Canada prohibits complementary insurance for publicly insured services [40]. Supplementary coverage is private health insurance that provides cover for health services not covered by the public system [40]. Obviously, most countries permit such coverage [40].

2.2.2 Decentralization and Privatization in Healthcare

Countries may involve the various levels of their government in finance, administration, and clinical decision making activities of healthcare policy and delivery. In the healthcare context, decentralization refers to the degree to which decision making power is transferred from the central, federal governing body to the more local authorities for purposes of operating the healthcare system. The degree to which a country chooses to decentralize healthcare policy and delivery is a function of the values of its constituents (e.g.: Canadian equity vs. American individualism) [61]. Synonyms for decentralization include the words devolution, de-concentration and delegation, although some authors will differentiate these words by exactly what responsibilities have been delegated and to whom. Despite recent policy change in Alberta [62], Canada has a relatively decentralized healthcare delivery model. Healthcare delivery is devolved to the 13 provinces, each representing distinct healthcare systems [55]. Many provinces have further devolved care delivery to regional health authorities (RHAs). The countries discussed in this paper have varying degrees of decentralization in their healthcare delivery systems. Since the various healthcare systems studied here are controlled at different levels of governance, the word "jurisdiction" is used to refer to the entity with responsibility for health information system policy and operations.

Decentralization (vs. centralization) is a vigourously discussed policy topic. Centralization and decentralization should be seen as a continuum along which countries trade off advantages and disadvantages according to the values of the population and the objectives of their healthcare agenda. In healthcare, decentralization is typically associated with more localized patient care. Decentralization typically results in a rationalization of health policy and strategy to the context of the local people. Sometimes a centralized approach may cause confusion and irrelevance when central policies are delivered in the localized context. On the other hand, centralization may offer some efficiency, such as the cost savings anticipated with the centralization of administrative functions.

An interesting diversion is the concept of privatization as a form of decentralization. If decentralization, devolution or delegation refer to the transfer of decision making authority from the central government to more local forms of government, then privatization may be considered as the delegation of tasks, decision making power and operations to the private sector. Privatization does not imply an abdication of decision making power by the public; it just takes a different form. In the public healthcare model, the voice of the paying public is heard through their vote at election time. The public may also exert socio-political influence through lobbying once the elected parties reach office. In the private healthcare model, economic and competition drivers control the market. Consumers exert control each time they open their wallet to pay for user fees, co-payments, or private insurance. One way to measure privatization is to examine the amount of healthcare expenditure made within the private sector. In this regard, Canada and Australia have relatively privatized healthcare systems, each with roughly 30% [2] of their healthcare dollars spent in the private sector (although they achieve privatization in different ways). If privatization is a measure of decentralization, the American healthcare system might be considered the ultimate decentralized system. In 2006, $723.4 billion or 66% of US healthcare spending came from private insurance [47]. By comparison, both Sweden and Denmark have less privatization (both with roughly 15% of healthcare expenditures [2]), most of which comes from out-of-pocket point-of-care payments. It is here where privatization as a measure of decentralization breaks down. Sweden and Denmark have relatively low private health insurance financing mechanisms, but both remain a relatively decentralized health system because of the immense decision making power held by Swedish county councils and Danish regions (considered secondary levels of government) in healthcare delivery. New Zealand's funding system lies somewhere in the middle with roughly 78% of health care spending coming from public sources [63]. New Zealand adults must co-pay for visits to their family physician implying a stronger privatization component as well as some controversy. Some poor New Zealanders are unable to pay for services even though it is usually the poor who require more care [64]. Community cards, reduced fees and subsidies for the poor, chronically ill and children are designed to address these concerns [63].

The degree of decentralization (vs. centralization) is manifested in and affects the HIT agenda since information technology is usually considered part of the administration of a healthcare organization [65]. As will be illustrated later in this dissertation, the degree of jurisdictional decentralization has an effect on how HIT is adopted within a country.

2.3 Domains of Care

In most countries, primary care is where patients engage their health system [66, 67]. Primary care is where more people receive care than in any other clinical setting [68]. Primary care physicians (PCPs), also called family physicians (FPs) or general practitioners (GPs), have the broad knowledge of medicine needed to tackle the wide range of health problems their patients present every day. Generally, primary care visits are short (no longer than one hour, but often shorter than 20 minutes [69, 70, 71]). When family physicians require more information to service their patients, they consult specialists, diagnostic services or OCHPs to acquire more detailed information about the patient's condition. Specialists are medical doctors who have received training, education and experience in a specific branch of medicine and are typically paid on a fee-for-service basis in Canada. When a FP refers a patient to a specialist, the physician transfers responsibility for care to the specialist. This is called secondary care. The specialist is responsible for diagnosis and intervention. The specialist may report back to the FP after treatment so that the patient can continue to be managed by their family doctor. Sometimes a FP may simply wish to consult a specialist for additional information or a second opinion on a patient's condition. In the case of consultation, no responsibility for care is transferred. The FP remains responsible and liable for care delivery.

In Canada, a disparity exists between FPs and specialists, which seems to be caused by education, remuneration, workflow and job design differences between the two. Specialists require more education to be certified. Specialists are paid on a fee-for-service basis, but rates are often much higher than those billable by FPs. In some job contexts, specialists do not need to pay overhead from the gross revenue generated by their billings. They practice in a ready-made job context where administrators and support clinicians are provided by hospitals or universities. FPs are paid on a fee-for-service basis but practice as small business owners. They must find office space, hire and pay support staff and manage through other fundamental business responsibilities characteristic of any Canadian small business. In some respects, they may have more business freedom than specialists, although they pay for it through higher overheads.

In Alberta, access to specialized medical care can be challenging for both patient and referring offices alike [72]. Patients are allowed to self-refer to specialists, but specialists are not remunerated well for this type of referral, therefore, practically all referrals come from GP offices [73, 74]. Specialist referral can be an onerous process for physician offices. Specialists have limited capacity to manage the large volume of referrals [75]. Most have developed specific fax or phone based processes to control the quantity and workflow of accepted referrals. These processes shift significant responsibilities back onto GP office staff, who spend considerable time coordinating the referral process [75]. Interestingly, a recent analysis of a decennial survey in south-western Ontario illustrated a relationship between the ease of the referral process and the timeliness of response back from specialists with FP job satisfaction [75].

Although the interdisciplinary dynamics don’t necessarily exist, a similar workflow can be seen between surgeon and pathologist when a surgeon consults a pathologist regarding the health status of a surgical patient. Pathologists are specialists who examine body tissues to make a diagnosis. A general surgeon consults a pathologist by providing a specimen, excised in surgery, to determine the health status of that specimen. In this case, the outcomes of the assessment are provided back to the surgeon who uses the information in forming an overall assessment of the patient's health status. In turn, the surgeon informs the FP to determine the care pathway to be taken.

Acute care is medical care administered for emergent, serious injury or illness, or for recovery from surgery. Acute care is care provided on an inpatient basis at an intensive level by a facility (hospital or emergent care centre) licensed and accredited to provide such services [76, 77]. Medical conditions requiring acute care are typically episodic, periodic or temporary in nature. Patients come to the hospital with acute illness episodes for complex issues that can no longer be managed in an outpatient setting. In contrast to primary care visits which may last less than an hour, patients may stay at the hospital for several days or weeks [78].

If acute care is responsible for managing emergent, episodic conditions, then primary care largely remains responsible for managing chronic disease. Chronic diseases are diseases of relatively long duration and generally slow progression. Some diseases, once acquired, cannot be cured. Chronic diseases (such as heart disease, stroke, cancer, chronic respiratory diseases and diabetes) are, by far, the leading cause of mortality in the world, representing 60% of all deaths [79]. Out of the 35 million people who died from chronic disease in 2005, half were under 70 and half were women [79]. The "epidemic" of chronic disease [11] requires a different approach to care management than what acute care and even traditional primary care permits. The long lived nature and slow progression of the diseases require care providers to engage patients in their own care. More time is required to educate patients so that they and their families (family members often become caregivers) can assist in disease management. As a result, more office time is required to manage and educate patients with chronic diseases than other care circumstances [3].

Community care usually consists of a series of programs delivered to a designated population with specific public health needs. Community care is provided outside of a hospital to citizens who may be older, financially incapacitated, mentally incapacitated or physically incapable of caring for themselves but still wish to live on their own. Home care programs are similar to community programs but are targeted at individuals who wish to remain in their homes for as long as possible [80]. Examples of community care and home care programs are rehabilitation programs, personal care programs, home support programs, caregiver relief, adult day programs, security checks and palliative care programs [81, 82]. Long Term Care (LTC) is care provided to people who are no longer able to care for themselves. LTC typically refers to care provided in seniors' homes to seniors with physical or mental disability [83]. Community care, home care and long-term care services are often provided by private for-profit and non-profit agencies in conjunction with RHAs or health ministries of secondary governments.

2.4 Primary Care Reform

A series of reforms have been undertaken in many countries to address the divergent trends in healthcare demand and supply at the primary care level. Primary care reform consists of several strategies to improve accessibility and continuity of care. In 2000, Health Canada implemented the Primary Health Care Transition Fund (PHCTF). The purpose of the PHCTF was to fund provincial and territorial efforts to implement sustainable, large scale change in primary care delivery [36]. The objectives of the PHCTF are:

- To increase the number of people with access to primary care;
- To increase health promotion, disease and injury prevention as well as management of chronic disease;
- To expand primary care services to 24 x 7 access;
- To provide access to the most appropriate care, which is best accomplished through interdisciplinary teams; and

- To ensure healthcare is coordinated and integrated up and down the complete care pathway [66].

Provinces and territories have implemented many programs to address the above objectives. Programs have included the implementation of interdisciplinary team care, expanded responsibilities for non-physician clinicians, changes to primary care pay models, aggressive healthcare promotion, disease prevention and injury prevention, rostering or assigning patients to designated physicians, increases in the number of community based 24 x 7 care centres and implementation of telehealth programs to provide access to services from a distance [36, 84, 85]. The following sections review primary care reform strategies relevant to the adoption of HIT.

2.4.1 Interdisciplinary team based care

Interdisciplinary teams are one of 5 key strategies under the PHCTF used to implement reform in the Canadian health system [66]. An interdisciplinary healthcare team is a team of nurses, dietitians, pharmacists, various therapists, mental health counsellors, and other clinicians who work together with the physician to provide care for patients. Physicians are considered part of and leaders of the interdisciplinary team. Interdisciplinary care improves patient care, health outcomes, access to health services, recruitment and retention of health providers, and is a more efficient use of health human resources [36, 86]. Under this strategy, the physician becomes the primary resource for assessment and diagnosis [86]. Diagnosis is a challenging task and makes the best use of physician skills, education and experience. Once diagnosed, the physician can engage other members of an interdisciplinary team for patient education, on-going monitoring and management.

The interdisciplinary team strategy is an integral part of primary care reform. Advanced access (described in more detail in Section 2.5 and later in Chapter 6) advocates that physicians delegate non-physician clinical tasks to other disciplines so that physicians can perform the tasks that only they are qualified to perform. The interdisciplinary team leverages the expanded scope of practice that nurse practitioners and pharmacists have recently received. Both nurse practitioners and pharmacists have recently acquired the ability to prescribe drugs or take other interventions. Nurse practitioners perform some diagnostic procedures and treatments including administering some medication [87]. The Ontario Ministry of Health and Long Term Care is even implementing nurse practitioner-led clinics to provide better care to unattached patients, to educate patients about disease prevention and health promotion, as well as to help navigate the health system [88]. Pharmacists not only dispense drugs but also manage conflicts with the rest of the patient drug regimen or allergies. In some provinces, qualified Canadian pharmacists now have the ability to prescribe drugs, a role previously bestowed on them in other countries [89]. Despite their advantages, interdisciplinary teams are not a perfect solution to the problem. They have significant communication challenges. Differences in education, socio-cultural background, perspectives on healthcare and different approaches to healthcare delivery can cause conflict within the team [20, 90]. Health Canada has initiated its Pan-Canadian Health Human Resources Strategy which contains an agenda to improve interdisciplinary collaboration through interprofessional education. Health Canada expects to enhance patient care and team performance by bringing interdisciplinary team members together through structured problem solving, decision making and socializing [90, 91].

Many jurisdictions have made significant investments in interdisciplinary strategies. In British Columbia, Integrated Health Networks (IHNs) are formal partnerships between physicians and health authorities to provide an integrated approach to primary care delivery. BC claims that integrating care from a variety of healthcare providers can reduce pressure on the BC health system and meet the individual needs of the patients better [92]. Ontario's Family Health Teams (FHTs) also use a team approach to care delivery [93]. In FHTs, healthcare professionals work collaboratively to provide comprehensive, accessible and coordinated family healthcare services to a rostered group of patients. The Ontario Ministry of Long Term Care's goal is to specifically address the healthcare demand presented by unattached patients [94]. Entering 2009, 7.5% of Ontarians could not find a family physician [95]. Twenty three percent of Ontario family physicians participated in 152 FHTs [95]. Other jurisdictions have been instrumental in formalizing interdisciplinary team care. New Zealand's Primary Healthcare Organizations (PHOs) are integrated healthcare delivery organizations designed to provide essential primary healthcare services to an enrolled population. Again, PHOs integrate physicians, nurses, health promotion workers, dietitians, pharmacists, and other care providers to serve the health needs of their enrolled populations [96]. Primary Care Trusts (PCTs) from the United Kingdom differ from IHNs and FHTs. Instead of being partnerships or joint ventures with the government or health authority, PCTs carry their own budgets and overriding priorities set by the associated Strategic Health Authority and the Department of Health [97]. PCTs are much bigger and more powerful than IHNs, FHTs and PHOs. About 80% of the NHS's budget flows through PCTs [98], whereas IHNs and FHTs are much smaller entities. Australia is still developing its primary care reform strategy [99, 100, 101]. Closer to home in Alberta, Primary Care Networks (PCNs) are a joint venture between a local group of family physicians and the local RHA to improve access to care for a defined, usually geographically contained, but unrostered, group of patients [67]. PCNs provide a team approach to providing primary care and thus most PCNs contain the same interdisciplinary team members adopted in other jurisdictions. Some PCNs have positioned themselves strategically to play a role in facilitating specialist referral and HIT adoption. Several PCNs have adopted specialist linkages programs that help FPs refer patients to specialists. Some PCNs have started to host specialist clinics where specialists come to PCN clinics on a periodic basis to see patients in the context of the interdisciplinary team [102, 103, 104]. Several PCNs have also hired dedicated IT resources to facilitate the adoption of technology within the PCN but to also provide technical support to physician offices. As with the other jurisdictions described here, physician offices remain independent businesses in the healthcare system.

2.4.2 Changes in remuneration models

Time is physicians' most valuable asset [105] and remuneration is recognition of this. In primary care, payment reimburses FPs for their time and covers overhead costs (rent, insurance, furniture, administrative staff, clinical staff, medical supplies, etc). Primary care in Canada is mostly made up of private practice physician offices. Most Canadian FPs are paid on a fee-for-service basis [106]. Table 2-1 shows the payment methods used to pay GPs in Canada, the United States, the United Kingdom, Australia, New Zealand, Denmark and Sweden followed by a comparison of physician office system adoption levels for these countries.

In recent years, jurisdictions undergoing primary care reform have examined remuneration models to determine if they could be used to change the way care is delivered. The following subsections illustrate the strengths and drawbacks of a number of remuneration approaches. As will be illustrated, different pay methods offer different behaviour incentives, some of which may be more conducive to supporting primary care reform and HIT adoption. There is also a relationship between physician remuneration (their primary source of income) and physician office reimbursement models used to facilitate and incent the adoption of HIT. Chapter 5 explores the relationship between remuneration policy and reimbursement strategies to understand how they combine to facilitate HIT adoption.

Table 2-1: GP remuneration method and physician office system adoption

Jurisdiction		Canada	US	UK	AUS	NZ	Denmark	Sweden
GP Payment	Fee-For-Service	90%[a]	19%[c,d]	30%[u]	100%[j,u]	15 to 30%[l,m]	70%[n,o,u]	20%[u]
	Salary/ARP		63%[c,d]					70 to 90%[q,r]
	Capitation		4%[c,d]	50%[f,g]		70 to 85%[l,m]	30%[n,o]	10% to 30%[q,r]
	Sessional/Hourly							
	P4P/Quality Based Pay			20 to 25%[h,i]				
	Blended							
Estimated physician office system adoption		26%[b]	24 to 28%[e]	89[b] to 99%[e,u]	80[k] to 98%[e,u]	92[k] to 100%[e,u]	99%[p,u]	90%[s,t] to 97%[u]

a. Carmel M Martin and William E Hogg, How family physicians are funded in Canada, Medical Journal of Australia, Volume 181, Number 2, 19 July 2004

b. The College of Family Physicians of Canada, Canadian Medical Association, The Royal College of Physicians and Surgeons of Canada. 2007 National Physician Survey. National Results by FP/GP or Other Specialist, Sex, Age, and All Physicians. Accessed at: http://www.nationalphysiciansurvey.ca/nps/2007_Survey/Results/ENG/National/pdf/Final%20Posted%20National%20Level%20Table%20Set/NPS.2007.National.Results.Binder.Final.pdf . Accessed 2008 December 11

c. Larry Green, How family physicians are funded in the United States, Medical Journal of Australia, Volume 181, Number 2, 19 July 2004

d. American Academy of Family Physicians, Practice profile of family physicians by family medicine residency completion, December 31, 2007, Accessed at: http://www.aafp.org/online/en/home/aboutus/specialty/facts/4.html. Accessed 2008 December 11

e. Ashish K. Jha, David Doolan, Daniel Grandt, Tim Scott, David W. Bates, The use of health information technology in seven nations, Int. J. Med. Inform. (2008), doi:10.1016/j.ijmedinf.2008.06.007

f. David P Weller and Alan Maynard, How general practice is funded in the United Kingdom, Medical Journal of Australia, Volume 181, Number 2, 19 July 2004

g. European Observatory on Health Care Systems, Health Care Systems in Transition, United Kingdom, 1999, Accessed at: http://www.euro.who.int/document/e68283.pdf. Accessed 2008 December 11

h. Mark Ashworth and Roger H Jones, Pay for performance systems in general practice: experience in the United Kingdom, Medical Journal of Australia, Volume 189, Number 2, 21 July 2008

i. Susan Maisey, Nick Steel, Roy Marsh, Stephen Gillam, Robert Fleetcroft, Amanda Howe, Effects of payment for performance in primary care: qualitative interview study, J Health Serv Res Policy, Vol 13, No 3, July 2008

j. European Observatory on Health Systems and Policies, Health Care Systems in Transition, Australia, Vol. 8 No. 5 2006, Accessed at: http://www.euro.who.int/Document/E89731.pdf. Accessed 2008 December 11

k. Cathy Schoen, Robin Osborn, Phuong Trang Huynh, Michelle Doty, Jordon Peugh, and Kinga Zapert, On The Front Lines Of Care: Primary Care Doctors' Office Systems, Experiences, And Views In Seven Countries, Health Affairs Web Exclusive, doi:10.1377/hlthaff.25.w555

l. Laurence A Malcolm, How general practice is funded in New Zealand, Medical Journal of Australia, Volume 181, Number 2, 19 July 2004

m. Bronwyn Howell, Restructuring Primary Health Care Markets in New Zealand: from Welfare Benefits to Insurance Markets, Australia and New Zealand Health Policy 2005, 2:20 doi:10.1186/1743-8462-2-20

n. European Observatory on Health Systems and Policies, Health Care Systems in Transition, Denmark, Vol. 9 No. 6 2007, Accessed at: http://www.euro.who.int/Document/E91190.pdf. Accessed 2008 December 11

o. Gosden T, Forland F, Kristiansen IS, Sutton M, Leese B, Giuffrida A, Sergison M, Pedersen L, Capitation, salary, fee-for-service and mixed systems of payment: effects on the behaviour of primary care physicians, The Cochrane Collaboration, 2008

p. Denis Protti, Steve Edworthy, Ib Johansen, Adoption of Information Technology in Primary Care Physician Offices in Alberta and Denmark, Part 2: A Novel Comparison Methodology, Healthcare Quarterly, Vol 10, Online Exclusive, May 2007

q. European Observatory on Health Systems and Policies, Health Care Systems in Transition, Sweden, ISSN 1817-6127 Vol. 7 No. 4, 2005

r. The Conference Board of Canada, Challenging Health Care System Sustainability Understanding Health System Performance of Leading Countries, July 2004

s. The Commonwealth Fund, Physicians Slow to Adopt Health Information Technology Cost Remains Biggest Barrier to Diffusion, Says Study, December 7, 2004. Accessed at: http://www.commonwealthfund.org/newsroom/newsroom_show.htm?doc_id=251807. Accessed 2008 December 13

t. Health Care News, European Physicians Especially in Sweden, Netherlands and Denmark, Lead U.S. in Use of Electronic Medical Records, Volume 2, Issue 15, August 2002

u. Denis Protti, Comparison of Information technology in General Practice in 10 Countries, Healthcare Quarterly, Vol. 10, No. 2, 2007.

2.4.2.1 Fee-For-Service Payment

The Fee-For-Service (FFS) system is most common in remuneration system in Canada and remains present in many international jurisdictions (advantages and drawbacks of the FFS model are shown in Table 2-2). The FFS system is a retrospective system that allows physicians to bill for each item of service they have provided to a patient. In most systems, fees are determined through negotiations between the payer and the profession association [107]. The FFS system is based on unique identifiers or codes which are assigned to each clinical task. Codes are assigned relative dollar values to express their relative importance in care delivery. As the physician works through the day, they and their administrative staff record the fee codes that are chargeable for the patients that they have seen. Physician offices then submit billing to the payer (the ministry of health) for payment.

Table 2-2: Advantages and Drawbacks of the Fee-For-Service Remuneration Model

Advantages	Drawbacks
• Encourages service provision or physician productivity [107] • Motivates long working hours [107, 110] • Encourages efficient time management [107] • May motivate performing of difficult procedures [107] • Cost efficiency of health technologies can be encouraged, if true costs are known [107] • Reward is fair, if prices reflect relative value [107] • Increasing workloads are rewarded with payment incentives [110] • Detailed record keeping provides a rich data source [107] • Familiarity with the system by payers and providers yields high acceptance [107] • Work is clearly linked to payment [110] • It is simple to understand.	• Requires detailed record keeping of procedures performed and is disliked by payers due to high administrative costs and difficulties in budgeting [107] • FFS can result in over-provision of care, provision of inappropriate services, or supplier induced demand [107] • Physicians have no incentive to perform un-remunerated tasks, such as patient education, counselling, returning patient phone calls or correspondence [107] • Motivates fraudulent up-coding of visits and procedures [107] • Motivates "ping pong" referrals between specialists [107] • Is not fair when fees are not reflective of relative values [107] • Rising healthcare costs, supported by FFS [107] • Fragmentation and failures of coordination in healthcare, supported by FFS [107] • Remuneration is driven by volume [107] • Fees associated with solitary services and activities might not contribute to the overall care of the patient or the achievement of targeted population health outcomes [110] • Some time-consuming services are inadequately remunerated, e.g. chronic care management, counselling or interdisciplinary collaboration [110] • There is a lack of dedicated remuneration for team-based activity [110]

When setting fees for services, estimates of resources used, time required to perform a procedure, type of setting, level of difficulty, expected volume of patients requiring the service and the level of provider training are considered [107]. Some jurisdictions use multipliers as a way to systematically increase fees upon completion of negotiations. Usually, a jurisdiction catalogues these fees in a schedule of medical benefits which is used as a reference by physicians [74, 108]. A significant amount of overhead costs exist in physician offices because physicians must track and archive their fee-for-service billings on a patient by patient basis. Even for solo practices, this administrative function can be quite onerous.

Under the FFS system, physicians are independent contractors in a single payer system (in Canada provinces are the payer/insurer for healthcare) [109]. The FFS remuneration model has been present in healthcare for many years, and as a result it is well documented in the literature.

2.4.2.2 Salaried Payment

Salaried payment is a prospective payment system which provides pay based on units of time as opposed to units of production (visits) [68, 107]. Prospective payment systems settle payment in advance of services rendered. Salary systems do not directly consider the costs of production, activities performed, or time spent with patients when determining the amount of pay. A salaried system could free a physician to take the needed time to investigate, purchase and learn to use HIT without significant lost revenue.

The salaried pay model suggests an important distinction in employment circumstance. The salaried pay model implies an employer-employee relationship exists between the payer and the physician [109]. Salaried pay structures require employers to make the appropriate payroll deductions that would apply to any employee. In Canada, Canada Pension Plan, Employment Insurance, federal and provincial payroll taxes would apply. Additional deductions, such as pension plans and other employment benefits, could be significant, but more importantly under a salaried pay model, they could be involuntary [111]. Under a FFS model, physician offices are generally incorporated, independent businesses with the physicians at the helm. As with any business, business owners enjoy a significant degree of freedom and independence which allows them to determine their own hours of work and who they work with. As business owners, physicians can control when and how they draw funds from the business to minimize their tax burden. Compared to the predominant and historical FFS system, salaried remuneration represents a radical departure in employment circumstance for physicians.

Salary systems do not directly consider the costs of production, activities performed or time spent with patients when determining the amount of pay. Since costs of production and time spent are not considered in pay formulation, a salaried physician is not incented to see any specific quantity of patients or provide a specific level of care [112]. Furthermore, some physicians may decide to qualify the patients which they choose to care for or even select fewer patients than they would under the FFS system. "Cream skimming" or "cherry picking" refers to the practice of accepting relatively healthy patients, while turning away relatively ill patients, to avoid associated risks, amount of time taken for care delivery and related costs. Still, salaried systems do have some advantages. Physicians can take more time with patients, since there is no lost opportunity cost with delaying the next patient [109]. More time may engender better physician-patient relationships [107]. Physicians can take the time to devise the most appropriate treatment plans. They have no incentive to over-provide and they have no incentive to over-refer patients to specialists. Salaried systems do not have the administrative burden of the FFS system. Salaried payment offers physicians more predictable and sustainable working hours, the possibility of employment benefits (health insurance, life insurance, pension plans, dental plans and other benefits might become more attractive to physicians as they age), the opportunity for paid holidays and time for continuing medical education [109]. Salaried payment disconnects physician remuneration from the number of patients seen by the physician in a given time period (patient volume) and permits physicians to make more liberal decisions about how they use their time.

Providers may engage in group patient consultations, or case conferences, the time for which is difficult to justify under the FFS model [110]. Case conferencing is a review of patient status in a meeting with members of the interdisciplinary team. Case conferencing has become a more popular method of communicating about patients with the advent of the interdisciplinary team and HIT. When case conferencing, each discipline describes the patient's health, proposed management plan and expected prognosis from their perspective. Led by physicians, case conferencing can be a powerful, but time consuming way of providing high quality care for complex care patients.

2.4.2.3 Capitation Payment

Instead of paying physicians on units of work or on units of time, the capitation model makes physicians holistically responsible to a panel of patients for a set portfolio of services [113, 114, 115]. Physicians receive a defined dollar payment per person per fixed time period [107]. The fixed fee can be flat or adjusted for various risk factors. For example, it is well known that, age and gender alone predict about 70% of the utilization of primary care services [115]. Accordingly, physicians on capitation payments may receive higher payment for older, female, rostered patients with chronic disease diagnoses as these complex patients often require significant time for proper care.

In a capitation system, physicians receive payment based on the number of patients they have on their patient panel or patient roster. A patient roster is a list of patients who are formally or informally enrolled in a practice or attributed to a healthcare provider [107]. Formal enrollment occurs when a patient signs a clinic's roster form that indicates that they will seek care with their primary healthcare provider at that clinic (except in emergencies) [116]. Physicians maintain a roster in a database and use it to gain payment from the payer. In some ways, rostering obligates patients to visit their primary healthcare provider before seeking care elsewhere [117, 118]. Informally rostered patients do not sign a roster form, but are attributed to care providers based on a systematic formula. Since no form is signed, physicians may be unaware of their true patient roster, unless they maintain their own list of patients. Similarly, informally enrolled patients may not be aware they have been assigned to a family physician for capitation payment purposes. There have been several models used to assign patients informally to physicians. Atlas et al. developed a system of attribution based on the primary care provider designated on hospital registration forms by the patient, the physician practice style, patient age, time since last visit with the physician and the patient's place of residence [119]. Alberta uses the 4-cut method for informally assigning patients to physicians. The 4-cut method uses 4 criteria (single physician seen, most visited physician, last physician to conduct physical exam or last physician seen) to allocate patients to physicians for purposes of capitation payment [120, 121]. New Zealand provides capitation funding based on a combination of health status, income, and age of patients [122].

Similar to salary, capitation payment is paid in advance of services provided (prospective). For physicians with an established roster of patients, the capitation payment system functions similar to salaried pay and, therefore, at least to some degree, the behaviours, strengths and drawbacks of the salaried system are similar in the capitation system [115]. Capitation generally discourages over-provision of care, encourages physicians to allocate their time appropriately to patients, encourages patient-provider relationship development and encourages cooperation with specialists [107]. The capitation system is relatively easy to understand, and although still requires some administrative tracking, is not as burdensome as administrating a FFS system. Capitation based on a roster creates the incentive for physicians to attract as many patients as possible to their office. Depending on the payment structure, they may be incented to attract perfectly healthy patients, who would never require actual care [107, 115]. Pay could equally be arranged to incent physicians to attract relatively unhealthy people who require on-going care. In Alberta, Alternative Relationship Plans (ARPs) possess many of the same qualities and structure as capitation systems in other jurisdictions. Family physicians in Alberta have the option to be paid via ARPs [113].

2.4.2.4 Sessional Payment

Sessional payment is another method of payment based on units of time. It differs from salaried pay structures in that sessional pay is usually for temporary work arrangements of relatively short periods of time, such as work done in an hour, day or week. Sessional payment is a retrospective time based pay method which is used to engage physicians for work that is separate from their permanent work relationship. One of the most frequent uses of sessional payment is to engage psychiatrists in hospital team consultation or in direct patient consultation. In such circumstances, the amount of time required with the patient may be quite disproportionate to the amount of time acknowledged under the FFS system. Sessional payment is often used by hospitals in paying physicians for "sessions" of work related to specific services [123]. Family physicians are paid a sessional rate to care for patients in community based emergent care centres where the patient volume may vary dramatically from day to day [124]. In such circumstances, they provide consultation services and have no control over scheduling or walk-up traffic. Sessional pay may also be used to pay specialists for providing consultation services to another professional. Thus, this pay model allows physicians to provide the needed duration and intensity of care where FFS payment is insufficient or patient volumes are unpredictable. Similar to salary and capitation, a sessional payment model facilitates case conferencing with salaried clinicians in an interdisciplinary team where the fee provided under the FFS model is insufficient for such work.

2.4.2.5 Payment for Performance

A relatively new form of compensation pays physicians for achieving performance or quality goals. These pay structures respond to the concern that other methods, especially FFS, focus more on volume rather than quality of work or outcomes [125]. The United Kingdom and some health systems in the United States integrate their well-established pay for performance programs into their overall remuneration packages [107, 126]. Alberta and Manitoba are initiating the development of pay for performance mechanisms in their respective jurisdictions [127, 128].

The American privatized healthcare sector offers a unique opportunity to study pay for performance because there are so many profit and non-profit funded programs in this multi-payer healthcare system. In 1999, the Institute of Medicine released its landmark reported entitled “Crossing the Quality Chasm: A New Health System for the 21st Century" which established 6 aims for quality improvement (safety, effectiveness, consumer-centric, timely, efficiency, and equity) [129]. These 6 aims form the basis for quality improvement in the United States. American pay for performance programs use a variety of methods to reward physicians for achieving targets. Positively oriented incentives such as fee differentials (percentage increases in reimbursement when quality standards are met) and bonuses are increasingly the models of choice (as much as 80% of P4P programs incent with bonuses [130]). Negatively oriented penalties, such as withholds and penalties, are rapidly declining in use.

American pay for performance programs focus on a range of performance measures. Certainly, clinical measures are a primary focus for performance remuneration. However, now as much as 50% of programs incent efficiency measures (such as the number of inpatient admissions or rate of prescribing generic drugs) [130]. Forty two percent of programs reward the use of electronic health records, patient registries and electronic prescribing [130]. It was estimated that by 2008 there was to be more than 160 US pay for performance programs covering more than 85 million Americans [130]. The mix of measures and their relative weighting are highly variable between programs since each program sponsor has different care goals.

Although the UK health system generally pays GPs through capitation models, a ubiquitous pay for performance model has been implemented to improve quality of care. The Quality and Outcomes Framework (QOF) is the UK's performance management and payment system [131]. Introduced in 2004, the QOF categorizes performance criteria into 4 domains: clinical, organizational, patient experience and additional services. A GP's practice receives money for quality in two ways. The practice negotiates the number of QOF points they are aiming for that year. A monthly payment equal to the value of 70% of these points is prospectively made to the practice. Remaining payments are made once the practice has actually achieved the points. The more points the practice generates, the more pay [132]. QOF has resulted in some improved health system performance. Even as early as 2004, the average practice achieved over 90% of its targets [133] suggesting strong motivation to improve quality and access performance funding. That is not to say that it did not generate some interesting behaviour. Many of the ratings were too rigidly implemented, overly simplified performance assessment, and resulted in manipulation of data or care circumstances to achieve targets [126].

Alberta, Ontario and Manitoba are also creating pay for performance programs. Manitoba's Quality Based Incentive Fund (QBIF) provides funding to clinics for meeting quality targets on selected clinical process indicators from the Canadian Institute for Health Information [127]. Once again, success within this program will require physicians to use a health information system to achieve QBIF's clinical targets [134]. Ontario has also implemented blended models for its Family Health Groups and Family Health Networks. The model incorporates pay for performance incentives which incent care provided to defined patient populations (mental health, palliative and senior patients) and unattached patients [135]. In 2009, 33% of Ontario family physicians were paid through an alternative payment relationship [95]. Alberta's Performance and Diligence Indicators program is a pay for performance program which will provide incremental remuneration to physicians who meet indicator benchmarks [136, 137]. The recent amendment to the existing Trilateral agreement provides funding to family physicians for two years, through fiscal year 2010-11, who demonstrate substantive clinical improvement [138].

2.4.2.6 Blended Models

As expected, a blended pay model consists of components from all of the above models. The purpose behind blending models is to design a pay system with uniquely positive benefits while breeding out the drawbacks. As a result, blended models represent an infinite opportunity to design a payment structure that meets the performance needs of the jurisdiction. The pay for performance programs noted above for the US, UK, Alberta and Manitoba are all, more accurately, blended models, by virtue of combining pay for performance with capitation (UK and US) or FFS (Alberta, Ontario and Manitoba).

2.4.3 Promotion of health and disease prevention

Another key element in primary care reform is the promotion of health and disease and injury prevention [66]. Many primary care strategies seek to address the supply side of the healthcare economy. Health promotion and disease and injury prevention seeks to affect the demand side by keeping people well and preventing diseases from occurring [139]. Health promotion empowers people to make healthy lifestyle choices and motivates them to take an active role in their own health. Patient-centered care, defined as care that elicits, respects, and incorporates patients' wishes and maximizes patients' subjective outcomes, is increasingly recognized as an important dimension of healthcare quality [140]. Disease prevention implements strategies to reduce the risk of disease, identify risk factors, or detect disease in its early, most treatable stages. Examples of health promotion programs are anti-smoking campaigns, anti-drug and alcohol addiction campaigns, well baby clinics, well woman clinics, and flu vaccination campaigns [4, 122].

Health promotion and disease and injury prevention empowers and requires people to take care of themselves. As we will see in the chapters that follow, HIT can be used to facilitate the strategy by giving patients an electronic avenue through which they can engage the health system. While technology can facilitate promotion and prevention, it is important to acknowledge that not all patients have the confidence, knowledge or aptitude to take on this responsibility. The most important factors contributing to health disparity (income, education, jobs and a sense of control over one's life [141]) would seem to be preconditions for patients' confident use of HIT when participating in the delivery of their own care.

2.4.4 Quality of Care and Healthcare Quality Assurance

Quality, in healthcare, refers to the degree to which healthcare is expected to increase the likelihood of desired health outcomes [142]. Safety, a related concept, is the prevention of harm to patients [143]. Healthcare quality assurance is a series of processes designed to ensure the care is accurate and error-free. Quality of care relates directly to adverse events which erode the quality of health outcomes. Even highly experienced and educated clinicians make diagnostic errors which can lead to incorrect patient management including delays in treatment or the implementation of incorrect treatment regimens [144]. Beyond diagnostic errors, there are also adverse drug events and admissions errors that can lead to adverse medical events. The Institute of Medicine in the United States reported between 44000 and 98000 deaths occur annually in US hospitals because of errors [130]. Davies et al. [145] reported that 21% of 4119 patient charts screened in New Zealand hospitals contained evidence of adverse events. Wilson et al. [146] reported that adverse events were associated with 17% of hospital admissions in Australia. In Canadian acute care hospitals, errors or adverse events were estimated to occur in 7.5% of patient admissions each year [147]. The Canadian Adverse Events Study reported that between 2.9% and 16.6% of patients experienced at least 1 adverse medical event and that 37% to 51% of these could have been prevented [147]. Errors occur both with and without technology and are sometimes even caused by technology [148, 149, 150, 151].

There are 4 general types of diagnostic error in health [152]:

- A false-negative diagnosis or under-call of the extent or severity of the complaint is when the patient is diagnosed as not having the illness when they truly do.
- A false-positive diagnosis or an over-call occurs when the patient is diagnosed as having the illness when they truly don't.
- Misclassification occurs when the patient is diagnosed with the illness but defects in surgical specimens, urinary tests or blood work are not representative or are inadequate for complete diagnosis.
- Defective reports are the fourth category of error. This includes reports with erroneous or missing non-diagnostic information (e.g., clinician name, date of procedure). Reports may also contain dictation errors, typing errors,

report format or upload errors. The Alberta EHR recently experienced an error of this nature [149].

Just as there are several types of errors [153], there are several healthcare quality assurance strategies that can be used to reduce, eliminate or palliate the implications of errors. "Clinical practice guidelines (CPGs) are systematically developed statements to assist practitioner and patient decisions about the appropriate healthcare for specific clinical circumstances" [154]. They define the role of specific diagnostic and treatment modalities in the diagnosis and management of patients. The guidelines contain recommendations that are based on evidence from a rigorous systematic review and synthesis of the published medical literature [155]. CPGs play a critical role in standardizing care delivery in specific care contexts. CPGs can be programmed into or accessed through HIT at the point of care.

Peer review is a process whereby lab test results, diagnostic images, specimens or other health evidence is reviewed to confirm the diagnosis and treatment [144]. Peer review can occur retrospectively or concurrently as a part of a healthcare quality assurance process. When used retrospectively, it is used to inform and educate clinicians as part of a professional development program designed to progressively improve accuracy in diagnoses. Peer review can be made blind to the recommendations of the original clinician or can be used to confirm the recommended treatment is accurate. Peer review is often used in pathology consultation [156, 157, 158, 159]. Second opinion is similar to peer review but is more often used to ask for advice or direction prior to the administration of treatment. Physicians sending patients to specialists for consultation seek a second opinion which will guide future treatment. Second opinion differs from peer review in that second opinion may provide a diagnosis independent of the initial assessment, whereas peer review is an assessment of the quality and accuracy of the initial diagnosis, which has since been acted on.

Another mechanism through which quality can be improved is the use of clinical decision support (CDS) systems to help avoid errors. CDS tools are integrated with CPGs, knowledgebases, algorithms and drug databases to provide drug-to-drug or drug-to-allergy contraindication warnings to clinicians as prescriptions are written. They are used to ensure a physician does not accidentally prescribe a treatment which will conflict with the patient's existing drug regimen or allergies. CDS systems can offer a level of standardization with regard to how care is provided, but the current literature is inconclusive with regard to whether such interventions practically work. A systematic review of CDS systems concluded that 62 of 97 studies reported improved practitioner performance, but only 7 of 52 found improvement in patient outcomes [160]. Many physicians leave drug-to-drug and drug-to-allergy management to pharmacists [161].

Yet a third form of healthcare quality assurance results from accreditation and certification of healthcare facilities. Accreditation is a rigorous evaluation process through which a third party assesses the quality of systems and processes used in healthcare organizations. The process of accreditation and resulting certification relies on the tenet that consistent and well designed facility processes will lead to higher quality of care [162]. The Leapfrog Group, launched in 2000 by a group of employers (in the US, employers are healthcare purchasers), has developed analysis approaches for assessing hospital safety [163]. The Leapfrog Group certifies the processes and practices which surround hospital systems. The Leapfrog Group's Hospital Safe Practice Survey is a survey of 30 safe practices [164, 165]. The Leapfrog inpatient CPOE (Computer Physician Order Entry systems are a type of hospital information and order entry system) standard includes a self-reported test which requires the hospital to demonstrate that their inpatient CPOE system can alert physicians to at least 50% of common serious prescribing errors [166].

Popular opinion advocates that the application of health informatics improves patient safety [167, 168], improves physician office efficiency [167, 168], and mitigates shortages in health human resources [168]. Contrary to these utopian claims, the studies discussed below illustrate how such systems can compromise short term physician office performance [169, 170, 171], intimidate physicians and their office staff [172] and have been shown, on occasion, to increase medical errors [150, 151, 173, 174]. The chapters that follow illustrate the failure modes of HIT and how implementers can address these concerns.

2.5 Advanced Access

Advanced access, sometimes referred to as enhanced access, open access, same-day scheduling or lean thinking, is a strategy for increasing capacity to deliver care [28, 175, 176] in physician offices, specialist offices, emergent care facilities and hospitals. Advanced access has several strategic components. Advanced access seeks to ensure that office tasks are appropriately matched to the right member of the physician office. When supply is matched to demand and tasks are properly assigned within the team, advanced access suggests that the waitlist will stabilize. A stable waitlist means the physician office is meeting demand, but still needs to work down its backlog to eliminate wait. Waitlists reduce profitability of physician offices and reduce job satisfaction [28, 177]. Waits tend to encourage patients to seek care where the wait is acceptable, even if it means seeing another physician. Studies show that patients are healthier when they see their own physician [121, 177, 178]. They visit the emergency rooms less frequently [177]. Once a physician office has control of its waitlist, the backlog can be worked down by addressing future demand. Where feasible, physicians should see patients for as many problems at once as they currently know about so that future appointments can be freed for future problems. Once sustainable, patients calling to see their physician can be offered an appointment the same day [176, 179]. Advanced access is not sustainable if there is a permanent mismatch between supply and demand [175].

2.6 Technology

Health Information Technology is a tool used to support the reform strategies discussed above. HIT helps coordinate care delivery provided by several disciplines.

It helps inform care by providing healthcare information used in previous encounters with the health system. It also helps to achieve some of the performance goals that are the foundation of pay for performance incentives. As with any vigorous debate, there are tradeoffs which need to be acknowledged. Some critics are concerned that electronification of health records heightens the risk of privacy and security breach. Others suggest that electronic systems remove the freedom of unstructured or less-structured free text that paper requires [180]. Paper records have long been established as the legal record referenced in the case of court action. Of course, most of North America's health records exist in paper form. It is not possible to toss away paper records without casting away our corporate healthcare memory. The ownership and intellectual property rights pertaining to electronic records are still being resolved [181]. Of course, the incumbent paper based system has its own short comings. Paper is slow. It can't easily be shared across distances. Physicians are notorious for poor eligible handwriting [182]. The lack of data sharing makes it difficult to collaborate with OHCPs. Care coordination requires telephone calls and faxes. And, ironically, paper systems also face their own issues with privacy and security, as shockingly described by Morrissey [183]. While health information systems offer the opportunity to escape these perils [184, 185, 186], care and responsibility must be taken so to avoid complications pertaining to changes in information systems.

HIT is computing technology which securely collects, stores, analyzes, manages and presents health information for a patient or a population. Figure 2-2 illustrates that health informatics can support an effective and sustainable healthcare system by improving patient safety [167, 172], physician office efficiency [105, 167, 172] and cost effectiveness [167]. Such benefits can only be achieved when the functional, technical and business concepts are considered in the adoption process.

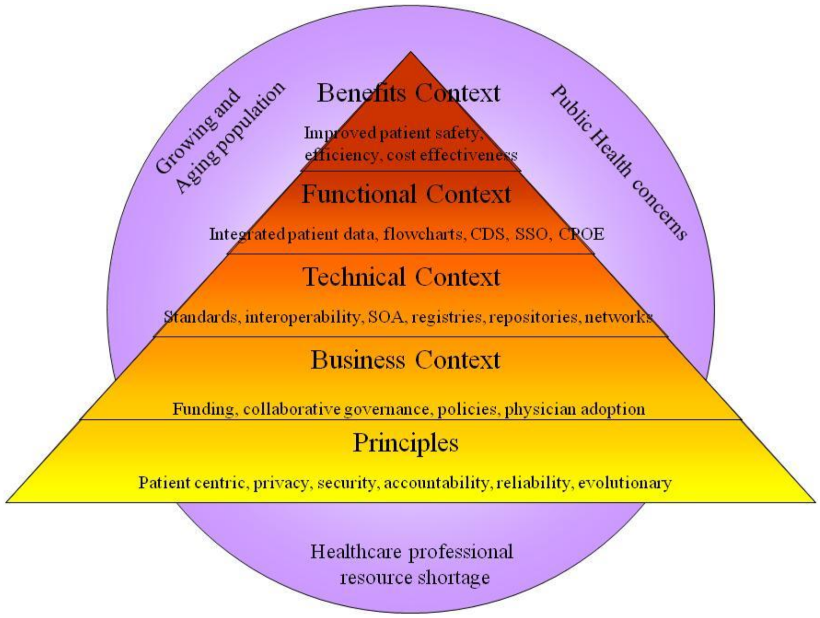

Figure 2-2 – Health Information Technology Benefits Context Diagram

The benefits pyramid rests on a layer of principles. The principles on which HIT is founded are those essential qualities of a health system itself. Different jurisdictions will have different principles and values. Patient centric focus, privacy, security, accountability, and reliability are core to the Canadian health system [187]. The Business Context brings resources and commitment, without which, HIT adoption can't be successful. Jurisdictions with solid funding sources have a better chance at implementing HIT. Collaborative governance models are vehicles through which various health system stakeholders are engaged and enrolled in driving adoption. With a strong foundation in principles and well articulated business processes, jurisdictions can invest in the technology needed to facilitate reform. The Technical Context contains the infrastructural, technical and operational elements needed to build a holistic integrated HIT environment. The Technical Context highlights the need for standards and architecture to drive a shared health information system. Outlined in future chapters, certification and conformance is an important facilitator of adoption. The Functional characteristics are those elements that allow the clinicians to be effective and efficient in delivering care. Functional characteristics need to support high quality healthcare by minimizing and avoiding errors. HIT functionality needs to fit within the operational context of healthcare organizations. Without good operational fit, adoption will be compromised. In a patient-centric environment, the health information follows the patient as the patient moves through the system. Quality improvement includes maximizing patient safety, respect for patients' time and resources by improving access to services, as well as efficiency and cost-effectiveness of health system resources.

2.6.1 Physician Office Systems

An Electronic Medical Record (EMR) (also referred to as a physician office system or practice management system [188, 189]) 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 EMRs may support order entry, results management and decision support [143, 190]. Some may also contain features or be integrated with software that can schedule appointments, perform billing tasks, and generate reports [191]. Providers use EMRs to record encounter, medical or physician-specific information [192]. 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. Thus, an EMR is a provider oriented health information system.

EMRs are delivered through one of three architectures. Many are delivered over Microsoft Windows based platforms, but some products are available in Mac and Linux platforms. The original desktop, or "thick client", architecture stores the application and its data on the physician's local computer hard drive. The thick client approach requires the local machine to perform all computing, only using the network for communications purposes. Performance is a function of CPU clock speed and RAM. Such systems are functional in extremely small physician offices where little or no data sharing is required between the physician, clinicians or administrative staff. Physicians can customize their EMR as they see fit without conflicting with any other physicians' work habits. Physicians operating a standalone desktop architecture must provide their own technical support – a role which many physicians may not be prepared for [193]. Physicians maintaining a desktop EMR can spend significant amounts of time providing their own technical support, taking valuable time away from providing patient care [194]. Desktop EMRs are usually only procured under out-right purchases (the physician buys and owns the license to use the software forever) as opposed to a subscription (monthly rental) fee. Such systems do not integrate with a shared health record. Jurisdictions promoting interoperability do not provide funding for these systems.

Another option available to physicians is the client-server architecture. Client-server refers to a network structure in which the server and network is local to the physician office. Data is stored on the local server and accessed using client computers over the local network. Client-server EMR implementations can have browser based user interfaces or have thick applications running on each local client computer which access data on the server [195]. Client-server architectures benefit from the performance of higher resourced servers, while client machines may be light (leaving data storage and most of the computing to the server). Physicians can customize their systems, although all physicians in the office may need to use the same customizations. The server facilitates interdisciplinary communication on patient files through a messaging feature [78]. The application database is stored on site, comforting physicians that the data is within their reach. Backups, upgrades and security are locally administered requiring the physician's attention or the services of a local computer support firm. Unfortunately these firms do not always appreciate the urgency or lost opportunity cost represented by a malfunctioning system [161]. Remote access is still possible in well-engineered products. Client-server EMRs can be purchased out-right or under subscription although maintenance fees are often charged for technical support, access to service packs and other updates. The networked nature of these systems allows them to exchange data on a jurisdictional health information exchange.

The application service provider (ASP) architecture provides the application and its data from a remote server over a network (internet). The application is accessed through terminal services, java or .NET interfaces. The application is served by a company called the application service provider whose purpose is to serve the application to physicians over a network while maintaining security and integrity of the application and its data. Some ASP vendors provide technical support and training for the application [195, 196]. The ASP model has several advantages which become more relevant in a patient centred, multi-provider and connected care delivery system [196]. Data is always securely stored. Physicians do not need to concern themselves with backups, backup power supplies or security. Security from fire, theft, vandalism or hardware failure is virtually assured. Computing is done by a remote server, allowing for relatively light client side machines. The only maintenance required of the physician office is that of their client side computers. Patient data can be accessed any time any where [195, 197, 198] usually without installing any specific software although sometimes terminal services client side software or java plug-ins are required. There are some drawbacks to the ASP model. There may be a loss of customizability of the interface or templates since the system may be in use by physicians who are not part of the practice. Some physicians also do not like the idea of someone else controlling their data – they see it as their intellectual property. ASP architectures have an Achilles heel. If network access is cut off, there is no access to the system. Also network latency may cause the application to appear sluggish when compared to desktop or locally hosted systems. Some GP system certification organizations are attempting to establish master service agreements (MSAs) which include measures of performance based on network quality of service. However, the ASP provider usually has no control over network performance and so cannot easily be held accountable for it. Most ASP offerings are paid via subscription based on time used, number of physicians (number of physician units) or number of patients stored in the system [198]. These systems may also exchange data on a jurisdictional health information exchange.

2.6.2 Electronic Health Records

An Electronic Health Record (EHR) is a patient-oriented, aggregated, longitudinal [199, 200] system of systems which assembles health information about a patient over a wide area network from, potentially, many geographically dispersed data sources. Owned by the jurisdiction (a province, as an example), an EHR provides each individual with an 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 healthcare providers and the individual anywhere, anytime in support of high quality care [201]. As shown by Figure 2-3, an EHR 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 lifetime health record about the patient [192, 201]. An EHR is a patient centric file that may contain information from a broad range of providers, including family physicians, specialists, social workers, pharmacists, radiologists, dietitians, physiotherapists, and nurses. As a point of distinction, many American sources refer to physician office systems as EHRs [168, 202]. For purposes of this thesis, EHRs are the patient oriented longitudinal systems of systems described here.

National or jurisdictional EHRs are on the healthcare agenda of several countries [203, 204, 205, 206, 207, 208, 209]. EHRs are a collection of data generated by the patient's encounters at various points of healthcare. In order to exchange data, an EHR requires source systems to be interoperable with central data repositories. Interoperability is the ability of a system to use or offer services from or to another system and exchange information with other systems to achieve a specified purpose [210]. Interoperability enables data and information generated by one system (ambulatory system, pharmacy system, laboratory system) to be accessed and (re-) used in a meaningful way by another system (drug repository, lab repository, hospital information system), whether or not the latter system is based on different technologies [211]. Interoperability is sometimes facilitated by an integration engine acting as an electronic health information exchange. For healthcare systems to share data, technical, functional and semantic interoperability needs to exist between systems. Technical interoperability simply refers to the networking connectivity between systems. Functional interoperability is the ability of components to exchange data. The component systems may not necessarily understand what is being exchanged [212, 213]. Semantic interoperability exists when applications understand and can manipulate the data being shared between them [212, 213].

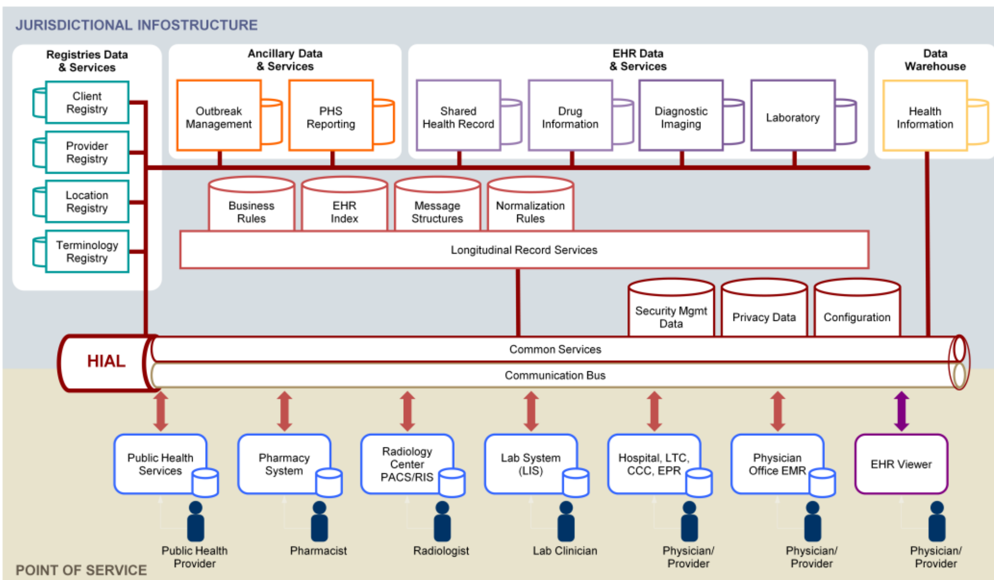

Figure 2-3: Canada Health Infoway EHR Conceptual Architecture [201]

To ensure source systems exchange data with central data repositories properly, a testing, conformance, accreditation, or certification process is required. These are processes through which health information system components (often implemented in isolation of each other by different people and organizations at different points in time) are tested to ensure they satisfy criteria contained within an interoperability specification [210, 214]. Technical system specifications together with interoperability standards, such as HL7 (Health Level 7 is a standard for transmitting text based clinical information), EDIFACT (Electronic Data Interchange For Administration, Commerce, and Transport also standardizes text based clinical information), DICOM (Digital Imaging and Communications in Medicine is a standard for transmitting diagnostic images), LOINC (Logical Observation Identifiers Names and Codes is a standard for identifying laboratory observations) and/or SNOMED (Systematized Nomenclature of Medicine standardizes references to organism names, topology, symptoms and pathology), describe how functional and semantic interoperability is designed within the system. Certification organizations confirm the implementation meets the design specification and thereby bridge the processes of system design and standards development with the practicalities of building interoperable health information systems [215].

Functional and semantic interoperability between legacy systems can often be facilitated via an integration engine (Canada Health Infoway's Health Information Access Layer (HIAL) is the integration engine in a provincial EHR). The integration engine is at the heart of the health information exchange (HIE). Integration engines abstract the complexities associated with the component systems that make up the infostructure, thereby allowing non-disruptive evolution of infostructure capabilities and applications at the point of service [201]. Integration engines support a simple message based approach (usually, but not limited to, XML) to sharing data between point-of-service applications and central data repositories. They facilitate the application of privacy and security rules [201]. Canada Health Infoway reports that it has approved 283 projects across Canada as of March 31, 2009 [216]. Planning is also complete for 173, each of which has either moved into the implementation stage or is complete and fully operational. The author's professional experience suggests that Infoway sometimes documents that its progress is farther ahead than actual status. Nonetheless, Infoway's influence in driving the Canadian EHR agenda is evident.

There are several software operations environments that support design, development, various modes of testing and production for infostructural components. In Alberta, all are based on AIX operating system platforms running the IBM Websphere 4.3 application server. Applications store data in DB2 relational databases which are accessed through 10/100 Mbps TCP/IP networks. Testing and development environments have 4 GB of RAM and production environments are loaded with 8 GB of RAM. Point-of-service applications are produced by a number of private, independent, for-profit software manufacturers using any number of combinations of operating systems, application platforms and database platforms requiring a myriad of hardware configurations.

EHRs are immense jurisdictional IT integration projects. In some cases, the EHR project is so big that no single organization has the engineering or human resource capacity to deliver it alone. In Alberta's case, in 2004, Alberta Health and Wellness wisely recruited the RHAs to assist in building the EHR. The RHAs had previously implemented integration engines, master patient indices and laboratory and diagnostic imaging repositories in their regional health information systems. Shared delivery of an inter-organizational, interoperable and interdependent system of systems requires immense coordination to make sure that the system components integrate appropriately. Alberta would not be alone in some of the technical breakdowns that have occurred over the life of the EHR project. The issues created by, and the strategies to address, a distributed EHR are explored later in this dissertation.

The strategic intention of building a shared EHR is to make clinical data from point-of-service offices, such as private practice physician offices, available to other care providers so that they have the full benefit of patient health history and previous interventions upon presentation. Jurisdictions are getting more aggressive in providing both incentives and penalties to stimulate adoption. American physicians who do not use physician office systems by 2015 will be penalized [217, 218]. Alberta's Bill 52, proposed in the Fall of 2008, is an amendment to the Health Information Act of Alberta (HIA) which would compel physicians to make their patient data available to the Alberta EHR. Penalties for non-compliance ranged from $200,000 to $500,000 [219]. The first draft of the Bill raised significant controversy because it compelled the sharing of health data previously collected in the private context of the patient-provider relationship. Such data is also seen as the private business intellectual property generated by the physician office [181]. Originally, the amendment would limit the amount of control Albertans and their physicians have over their health data [220]. In the spring of 2009, changes pertaining to privacy agreed to by the Alberta Legislature's all-party Standing Committee on Health resulted in physician support for the Bill [221]. The extensive details of these modifications are beyond the scope of this thesis but, in summary, required the jurisdiction to continue privacy impact assessments of new collection, use or disclosure of patient information, continue to honour patients' requests for masking of private patient data and remove penalties to physicians for non-compliance [221]. On the one hand, EHRs facilitate the exchange of clinical data making it available anytime, anywhere for patient care delivery. However, it is clear that this objective changes the way the healthcare system thinks about its data.

2.6.3 Telehealth

Telehealth, also known as telemedicine, is the use of information and communication technology to provide healthcare when provider and recipient are separated by distance [222, 223]. Telehealth helps to address the gap between healthcare supply and demand by making healthcare services available to patients separated geographically from providers. Telehealth can be used for many purposes. Telehealth can facilitate continuing medical education [224, 225], team building [226], specialist consultation [227], second opinions regarding diagnoses [158], or peer reviews [159] as part of a quality assurance process. Some practitioners have embraced telehealth technology as a means to improve access to services across geographic separation. Others are skeptical of the technology. Skeptics feel liability, data security, and costs erode the care-giving value of the technology [228]. Factors such as physicians' limited abilities to practice across jurisdictions, reimbursement, liability concerns and a general lack of understanding of the technology have hindered adoption of telehealth in many areas of care [229].

There are generally two types of telehealth technology. Store and Forward (SF) telehealth involves the capture of digital records of diagnostic information (such as a digital image of a skin lesion in teledermatology, digital images of cellular structures in telepathology or a digital sound recording of a heart beat from telecardiology) which are then sent to a remote specialist for consultation. The specialist reviews the diagnostic information as their schedule permits and returns a recommendation to the referring physician [227, 230]. The asynchronous nature of SF technology can facilitate specialist referral sooner than would be attainable through conventional specialist referral [227, 230]. SF telehealth uses relatively unsophisticated, low cost and easy to use technologies (secure file transfer, secure email) to transfer the data.

The second type of telehealth uses real time (RT) media streaming, video and conferencing technology to facilitate data transfer. Popular in continuing medical education, telepsychiatry and teledermatology, RT telehealth allows local clinicians to access remote specialists in real time to gain timely diagnoses. Real time audiovisual interaction allows the specialist to interact directly with the patient without having to share the same physical location. The remote specialist can query the patient or accompanying clinician to gain more information. Although RT telehealth is more personable and treatment suggestions may be rendered immediately, schedules must be coordinated to make this method of consultation achievable [227].

Canada's geographic magnitude has required it to develop many examples of telehealth systems. One of the largest, most prolific and successful telehealth programs is the Ontario Telemedicine Network. As a great example of extending and enhancing access to care for remote patients, the Network uses two-way videoconferencing systems and tele-diagnostic instruments (like digital stethoscopes, otoscopes, high-resolution patient examination cameras, and endoscopic equipment) to deliver clinical care and professional education among health care providers and patients [231]. The Network helps more than 2,000 healthcare professionals to deliver care from over 600 sites across the province. In 2008, more than 42,000 clinical consultations in Ontario were conducted using telemedicine [231]. Another successful telehealth program comes from Australia. Australia's geographic expanse has also required it to develop telehealth programs to provide access to services. The Australian Health-e-Screen 4 Kids mobile e-health van collects patient health information by local caregivers and makes it available to remote specialists for case review, diagnosis and recommended care pathways for remote indigenous children. Health workers collect patient information and digital images, together with a clinical history of the patient, hearing assessment and health risk questionnaire then transmit it via internet connection to a hospital where specialists review the information. The program helps to monitor children at risk of developing chronic disease [232].

2.6.3 Other systems

Empowering patients in managing their own care is a key objective of primary healthcare reform. A powerful tool that can assist in promoting health and engaging patients in their own care is the personal health record (PHR). A PHR is a computer program used to record healthcare events by the patient for the patient [233]. Whereas a PHR is often a software program installed on the patient's local computer, a Health Information Bank is an online service hosted by an organization which provides a patient's personal health information to healthcare providers, as designated by the account holder (the patient) [234]. Recently, the Canadian Medical Association [235], Microsoft [236] and Google [237] announced plans to construct consumer oriented patient health records and health information banks. PHRs let individuals enter, organize and retrieve their own health information. They capture the patient's concerns, problems, symptoms, emergency contact information, becoming the patient's equivalent to the physician office system [233]. Some PHRs can share selected, clinically relevant health data from the physician office system [233, 235, 238] as a means of communication from the physician to the patient. There are several key features of PHRs which engage the patient in their care. Many have healthcare reminders, such as appointment reminders, reminders to take drugs or follow up on physiotherapy [233]. They might have tracking tools to track blood sugar, weight and physical activity for chronically ill patients. They may also have databases of clinical information, written in layman's terms, to help patients read up on ailments and concerns. They may be used as vehicles in health promotion and disease prevention [233]. Ideally, they interoperate with a physician office system or even an EHR to support safe and timely healthcare delivery [233].

Patient self-booking systems, sometimes integrated into PHRs, form part of a complete patient self-management system. Self-service includes a number of tasks which the consumer can complete on their own in the delivery of their own care. Self-service systems insert patient bookings directly into EMR scheduling modules and can automatically send out email or even snail-mail reminders for upcoming appointments [239]. Online appointment booking and online self-cancelation systems involve the patient in their own care and help minimize lost revenue in physician offices due to no-shows and cancelations which can constitute a significant cost to physician offices. Seven to 20 percent of appointments in a doctor's practice may turn out to be no-shows [240]. Medical practices mail out letters and even call patients to mitigate the risk of no-shows [239] at significant expense. Automated online booking systems are capable of handling concurrent bookings, as opposed to a medical receptionist, who sometimes places patients on hold to manage call volume. Not only can these systems save money, but some healthcare providers have realized an average increase in patient throughput of 10 percent and an average reduction in registration time of 75 percent [241]. Micro practices (family practices run by a sole practitioner who replaces all staff with HIT) represent the ultimate in patient delegation; they use HIT to eliminate staff overhead and delegate booking, cancelations, check-in, problems, symptoms and emergency contact information to patients [242, 243, 244, 245].

CPOE systems are electronic systems (often, but not exclusively, implemented in hospitals) where physicians enter [246] and manage [247] orders for medications, diagnostics tests and other services. CPOE systems are another method of integrating healthcare providers in the delivery of care. CPOE systems have been integrated with CDS systems to aid the clinician in the safe delivery of care. CDS systems use knowledgebases and algorithms to generate patient-specific recommendations [160]. Recommendations are based on several patient characteristics such as age, gender, allergies, drug intolerances, and history. The systems can advise clinicians with alerts for critical biomedical values, reminders for overdue preventive health tasks, drug doses, reminders for prescription renewals or reviews, and drug-to-drug or drug-to-allergy contraindications. As described previously, the Leapfrog Group made the implementation of CPOE systems a key part of its hospital safety initiatives [163, 164, 165]. Adverse Drug Events (ADEs) are current, common and costly issues in healthcare [248, 249]. While CPOE is a strategy implemented to reduce medical errors, other studies have shown them to be a cause in such events [150, 151, 250, 251]. CPOE systems are not widely adopted in hospitals for several socio-technical reasons [160, 247, 252].

2.6.4 Standards

This dissertation will use the word "standards" in several different contexts and therefore it is advantageous to define the use of the terms so the reader is prepared. Standards for interoperability have already been discussed above. These standards describe the message structures that are used for transmitting various types of medical data between interoperable applications. Standards such as HL7, EDIFACT, DICOM, LOINC, and SNOMED define the basis upon which interoperability is built. Without standards for data transmission, inconsistent data conversion rules would lead to significant cost and potentially significant numbers of errors. The implications of these standards on quality and patient safety will be discussed later.

Another standard referred to later in this dissertation is the standard software operations processes that fall under the Information Technology Infrastructure Library (ITIL) software operations management framework. ITIL advocates for standards in software operations workflow processes which allows for the coordination of software maintenance by many interdependent organizations. The Alberta EHR described above is being developed by several healthcare delivery organizations. Software operations requires coordination across delivery organizations to ensure that changes to the software and their subsequent release into the production environment do not lead to incompatibilities between interdependent software applications operating in a service oriented architecture.

Standards offer physician offices a risk mitigation method when implementing health information systems. Standardization represents agreement among staff and physicians in a clinic regarding how their new system will be used. For example, it may be important to standardize on specific medical terminology that will be used to document given morbidities so that when such terms are used, all staff understand what the documentation refers to. It may be important to agree on ranges for lab test results which indicate positive or negative diagnoses. If a patient's lab test result falls within a given range, staff will all know that the test result was normal. If a lab test result falls outside the range, all staff understand that the lab test result is abnormal and will require further investigation and intervention. Lab test results ranges are particularly important because different education institutions and different healthcare disciplines establish slightly different ranges as normal. If physician office staff acquire their base education from different institutions, there may be an opportunity for confusion and miscommunication when lab test results ranges are not standardized. CPGs are another example of standards. CPGs are protocols, based on evidence, which guide clinical decisions. They provide criteria for diagnosis, management, and treatment.

Chapter 3 – Methods

3.1 Methodology Background

The research question, "What is the effect of information and computing technology on healthcare?", was suggested by industry companies working in coordination with TRLabs and the University of Alberta. This question was selected because these organizations wished to acquire more information about the dynamics of HIT adoption.

Courses were selected to build knowledge in the area of healthcare, healthcare policy, electronic healthcare systems, intellectual property, ethics and research methodology. Table 3-1 lists the courses selected to complement the industry work experience that had been acquired by the author to that point. Course deliverables were designed to meet the requirements for credit but also to contribute scholarly works in the health informatics community. Courses were complemented by attendance at a series of seminars and conferences which added to the information described in this dissertation.

Table 3-1: Courses

University	Faculty/School	Courses
Victoria	Health Information Science	HINF516 – Telemedicine in Action
Victoria	Health Information Science	HINF551 – Electronic Health Records
Alberta	Engineering	ENGM665 – Intellectual Property
Alberta	Public Health	PHS709 – Comparative Health Systems
Alberta	Medicine	MED571 – Directed Reading in the Basic Medical Sciences
Alberta	Engineering	ENGG600 – Engineering Ethics

When opportunities presented themselves, the deliverables from the above courses were used to generate articles, presentations and posters submitted for publication in scholarly journals. These papers were purposefully researched using various methodologies to gain experience in various research methodologies. Additionally, papers were deliberately written with a number of contributing authors to gain the perspective of others' ideas and interests.

There are many matters in health informatics which would form excellent and timely topics for research. Topics such as how health informatics affects patient safety, privacy, staff anxiety and quality of care are relevant issues in the emerging health informatics domain. During the candidacy review process, three supporting research questions were developed to focus the main research question and to acquire more detailed knowledge in selected areas of health informatics. These supporting questions were selected because they are immediate and current issues in the field of health informatics and policy. The questions represent issues that the author, as General Manager of the Sherwood Park PCN, addresses with physicians on a regular basis. Table 3-2 lists those 3 supporting research questions. A total of 10 publications were produced through the course of this work [78, 161, 193, 215, 227, 230, 253, 254, 255, 256]. Table 3-3 and Figure 3-1 illustrate how the articles apply to the research questions and the methods used for the research. These major themes form the basis for the following chapters.

Table 3-2: Supporting research questions

	Supporting Research Questions
1	How does physician liability affect the adoption of health information technology? Do physician office systems certification organizations mitigate the liability risk to physicians?
2	Do general practice remuneration and health information systems funding combine to facilitate adoption of physician office systems?
3	Does telemedicine facilitate peer review and second opinion in primary care? How does telemedicine affect the referral process to specialists? Does telemedicine facilitate access to specialist services for patients?

Table 3-3: Relationship between Published Articles and Research Questions

	Article Title	Related Research Question	Chapter	Method
1	The Effects of Telemedicine on the Pathology Process [230]	3	4, 5	Literature Review
2	Adopting EMRs in Primary Care: Lessons Learned from Health Information Systems Implementation Experience in Seven Countries [253]	1, 2	4, 5, 6, 7	Literature Review
3	Primary Care Physicians' Experience with Electronic Medical Records: Barriers to Implementation in a Fee-For-Service Environment [161]	2	4	Semi-structured physician interviews
4	The Implementation of Operational Processes for the Alberta EHR: Lessons for EMR Adoption in Primary Care [193]	1,2,3	4, 5, 7	Experiential
5	A review of GP system certification programs in 7 countries and 5 Canadian provinces [215]	2	5	Literature Review
6	Primary Care Physicians' Experiences with Electronic Medical Records - Implementation experience in urban, hospital and academic family medicine [78]	2	4, 5, 7	Semi-structured physician interviews
7	Evaluation of a telehealth clinic as a means to facilitate dermatological consultation: A pilot project to assess the efficiency and experience of teledermatology used in a Primary Care Network [227]	3	4, 5	Semi-structured patient and physician interviews
8	Improve office efficiency by putting your patients to work: Case Study Part 1 of 3: Workflow implications of an online self-service appointment scheduling system in family practice [254]	N/A	6	Semi-structured physician interviews
9	Improve office efficiency by putting your patients to work: Case Study Part 2 of 3: The financial viability of an online self-service appointment scheduling system in family practice [255]	N/A	6	Experiential
10	Improve office efficiency by putting your patients to work: Case Study Part 3 of 3: Patients' perspectives regarding online self-service appointment scheduling in family practice [256]	N/A	6	Patient survey

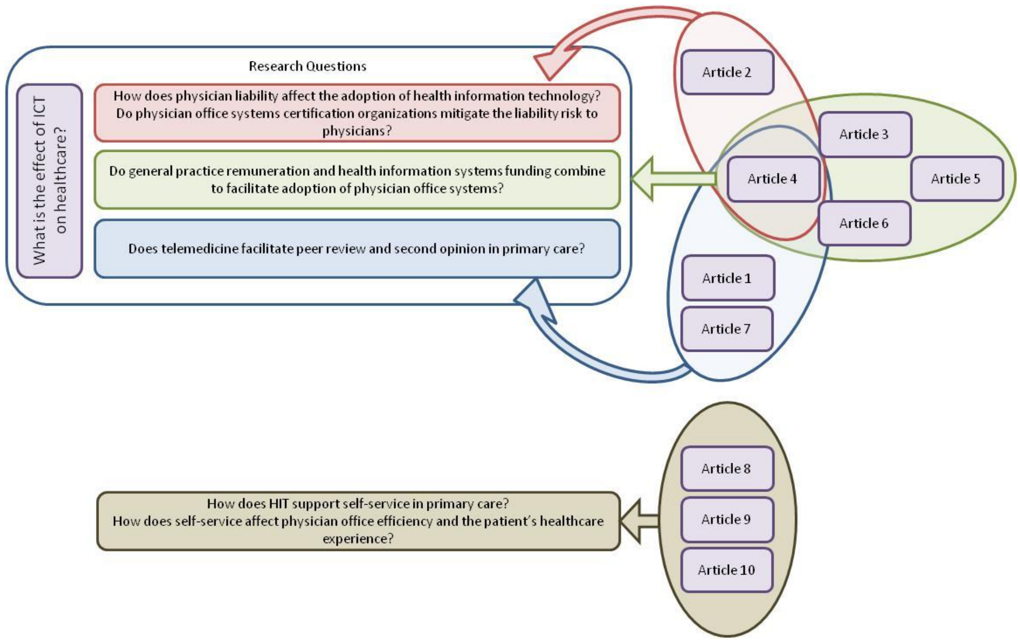

Figure 3-1: Relationship between Published Articles and Research Questions

3.2 Literature Reviews

3.2.1 Telepathology literature review

Several methods were used to gather data for the research. Articles 1 [230], 2 [253] and 5 [215] were literature reviews. Article 1 [230], published in the conference proceedings of the Third IASTED International Conference on Telehealth, followed a simple, non-exhaustive review of peer reviewed and grey literature exploring the adoption of telehealth technology in pathology. Two pathologists were interviewed to understand their perspective on telehealth technology in pathology. Inclusion and exclusion criteria were developed to assess relevance of articles found in a general internet search using the Google search engine. Articles were assessed for relevance by applying inclusion and exclusion criteria to article titles. If they proved relevant, then abstracts were read and compared to criteria to further assess relevance. If abstracts met inclusion and exclusion criteria, then articles were critically appraised. An immersion/crystallization technique produced the main findings.

3.2.2 International literature review

Article 2 [253], published in the International Journal of Medical Informatics, was a key contribution that forms the backbone of this dissertation and a platform on which the rest of the articles and this thesis are based. The article hypothesized that HIT implementation has both intended and unintended workflow and organizational impacts. This study used a two phase literature review approach conducted by one reviewer (Figure 3-2). During the first phase, the research question, "What lessons can adopters of Electronic Medical Records in general practice learn from previous implementation experiences?" was developed. Then, a hypothesis was created which explored the concept that experiences from many types of health information systems implementations in many types of care settings could be applicable to adopters of EMRs in general practice. To investigate this hypothesis and to broaden the search, the research question was broken down into component parts and expanded to include several types of health information systems, types of health care settings, and jurisdictions. Data from Canadian provinces was limited to western Canadian provinces plus Ontario because of the author's proximity and personal interest in these provinces. Finally, inclusion and exclusion criteria were developed from the reviewer's general understanding of health informatics. The criteria (listed in Appendix 1) were used as a filter to ensure that the most pertinent articles were included in the search results.

The search was conducted through the University of Alberta's online library system. A search string was developed from search synonyms developed through the decomposition process described above and then customized to fit the search engine requirements for each of six databases (Appendix 1). Even though databases are often seen as secondary sources of data, they were searched first because their search engines were found to be far more robust and sophisticated in their features than journal website search engines. Appendix 1 lists the databases, journals, grey sources, college and professional associations as well as government and commission websites that were searched in this review.

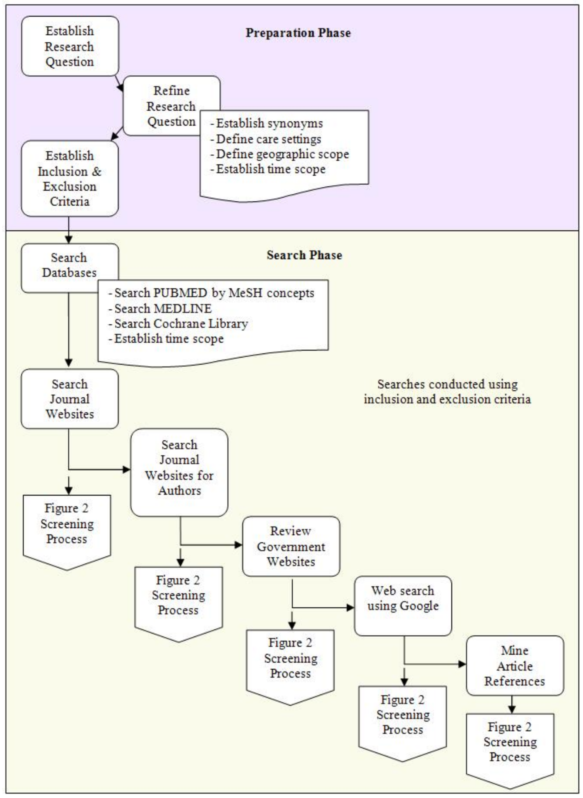

Figure 3-2: Literature Review Approach

Peer reviewed articles published between 2000 and 2008 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 [257]. 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.

A single reviewer, the author, searched the sources above to collect articles for structured literature review. As articles were returned by the searches, the inclusion and exclusion criteria were applied simultaneously to assess article relevance. Figure 3-3 illustrates the process used to screen documents for relevance. A Literature Review Search Log was created to record search results and keep aggregate statistics of the articles as they passed through the screening process.

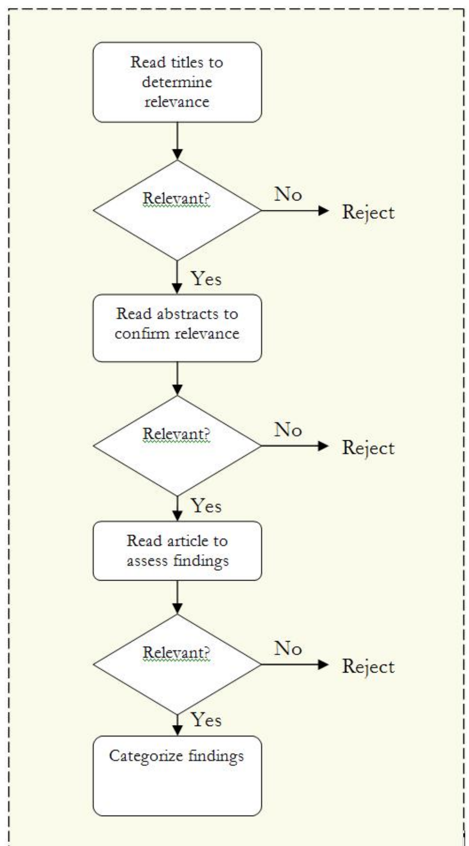

Figure 3-3: Article Screening Process

When searching the data sources, the raw number of titles initially returned by the search utility was recorded in the Log. Then, the titles were read and criteria were applied to determine if they were relevant to our topic. If an article appeared to be relevant based on its title, then the article, where available, was downloaded to a local data store so that its abstract could be reviewed after all title searches from all data sources were complete. If the article was not available, then the reviewer would try to acquire an abstract. If an abstract was not available, then at least the title was stored for completeness and statistical purposes.

Once all sources were searched by title, the screening process was resumed by reviewing abstracts of the articles in the data store. If the abstract indicated the article could have useful information in it, then the whole article was returned to the data store to be read. Others were discarded. The last step in the process was for articles to be read in detail. Articles were read twice to assess relevance and to extract data for our structured review.

An article review table was created to record statistical and critical appraisal data for individual articles. As the articles were read, data consisting of authors, year of publication, title, keywords, objectives of the study, time frame of the study, country, target population of the study, sample size, setting, system implemented, method, results, conclusions and recommendations were extracted from the articles and recorded in the table. Some narrative reviews did not follow a standardized peer reviewed report format making it difficult to extract this data. In these cases, the reviewer read the complete article and then completed the table with data interpreted from the articles. In a few cases, some of the data was simply not available or not applicable and so was reported as such. After recording this data, the reviewer critically appraised the articles. Articles were assessed to understand the breadth of the topics covered. In these abridged appraisals, the articles' strengths and weaknesses were recorded. Gaps in the article were also documented. It was during this appraisal that the reviewer noticed that the articles' main messages could be grouped into a series of factors to help support future synthesis. Due to time lines of the project, no attempt was made to contact article authors to answer questions that came up during the review of the article.

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 to titles 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.

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. Remaining 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 (n=35), general practice/primary care (n=34) or no specific or documented setting. 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 (n=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.

3.2.3 Conformance and certification organizations literature review

Article 2 reported that physicians' concerns about how HIT adoption affected their professional liability deterred their interest in and rate of HIT adoption [140, 167, 227, 230, 258]. Articles found during the literature search described above asserted liability could be mitigated with the adoption of health information systems, but did not support the assertion with a study or any substantiated information [253]. The project leading to Article 5 [215] (published in ElectronicHealthcare) was undertaken to explore this concept further. The study hypothesized that certification organizations don't mitigate liability, financial and procurement risk because there was no support to their claims. The objective of the project was to review organizations which certify physician office systems to understand their role in adoption. A literature review, following the same process shown in Figure 3-2, of English language peer-reviewed, grey literature, government and organizational websites as well as trade press, general press, and online sources published from 2005 to October 2008 was conducted. Peer reviewed articles were searched on MEDLINE, PUBMED, EMBASE, and The Cochrane Library. Health informatics journals were searched for articles not yet indexed in the databases (see Appendix 2 for a detailed list of sources and search strings). References of articles were reviewed to mine for further relevant articles. Little information was found in peer-reviewed literature and therefore organizational websites and documentation were hand searched for relevant information. These findings were qualified by consulting key informants. As described above, inclusion and exclusion criteria were applied as shown in Figure 3-3 to screen articles for relevance. Four databases, 11 journal websites, 15 websites from grey sources, 10 medical college and professional association sites as well as 21 government/commission websites were searched. The searches returned 2705 article titles. Applying inclusion and exclusion criteria produced 246 articles whose abstracts were reviewed. Screening the articles by abstract reduced them to 150 articles. After reading, 51 unique articles met our inclusion and exclusion criteria. Fifty one percent of relevant articles were found on government/commission websites, 15% were found in databases and 10% were found in journal websites. Eight percent were found through a general internet search using Google Scholar, 8% were found through other grey sources and 8% were found through college and professional association websites and documentation.

3.3 Semi-structured interviews

Article 2 reported a number of risk factors which adversely affect outcomes of HIT adoption in many domains of care. It also reported a number of insulating factors which adopters can use to ensure their implementations are successful. The purpose of the project leading to Article 3 [161] (published in the International Journal of Telemedicine and Applications) was to assess the relevance of these findings in the Alberta primary care context. The paper hypothesized that these risks are relevant in community care, but other factors may also affect adoption. We expected that physicians did not follow a rigourous procurement process because they don't have the time. We also expected that exam room layouts did not optimize patient-provider relations. The project used two methods to gather data. One hour semi-structured interviews were used to acquire information from family physicians' experience of selecting, implementing and operating a physician office system. Physician candidates were selected from a local Primary Care Network. Inclusion criteria required physicians to be practicing full time in the community, have significant experience operating an EMR and be a lead physician or influencer in clinic decision making. An interview guide (Appendix 3) was developed from the findings of the international literature review. It consisted of closed-ended statistical questions and several open-ended questions to capture data about adoption experiences. The researcher recorded detailed notes that were later used for synthesis and analysis. After the interview, the researcher documented the layout of exam rooms. Exam rooms were depicted in floor plans which conceptually located the computer keyboard and monitor with respect to the patient exam table or chair. Physicians demonstrated the positioning of the patient with respect to themselves and the computer. Exam room layouts were subsequently analyzed and categorized into three general types for critical review.

At the time, there were 47 physicians in 19 clinics practicing in Sherwood Park. Eleven of those 19 physicians made significant use of EMRs. Nine of 11 physician leaders with enough EMR experience agreed to be interviewed representing 26 physicians. Interviews were conducted during the months of February and March 2008. Two interviewees were sole practitioners, 2 interviewees represented clinics with 2 physicians each in them, 3 interviewees represented practices with of 3 physicians, 1 interviewee represented a clinic of 5 physicians and 1 interviewee represented a clinic of 6 physicians. At the same time, 19 exam rooms were viewed representing 51% of the total 37 rooms in these physicians' offices.

Article 3 revealed two interesting concepts. The article concluded that suburban physicians do not have or take the time to properly investigate the HIT product market, follow a procurement process, implement the system, and then train to use it. The article also contemplated whether the current fee-for-service payment model compromises adoption by exacerbating an urgency to maintain patient throughput. Determining whether these two factors pervade other primary care delivery settings could offer insight into how adoption takes place. A follow up study, documented in Article 6 [78], examined the adoption experiences of urban, hospital based and academic physicians to understand if these same factors affect adoption in those care settings. The study hypothesized that physicians paid on a salaried basis (more accurately, a non-FFS basis) have more time to follow a complete procurement process that leads to a better selection for their practice. Purposive sampling was used to identify 16 urban, hospital based and/or academic physicians for interviews. Due to our small sample size, maximum variation sampling based on gender, work location (hospital vs. urban clinic vs. academic setting), remuneration model (FFS reimbursement vs. an ARP), and years of practice experience was used to select interviewees. Key informants were physicians with recent EMR implementation experience. Inclusion criteria (confirmed during interviews) required physicians to be practicing in one or a combination of the above settings. Criteria required physicians to be a lead physician or influencer in clinic decision making. The researcher used one hour individually conducted semi-structured interviews to acquire descriptive data. An interview guide (Appendix 3), consisting of open-ended and closed-ended questions, was developed to stimulate a qualitative description regarding the experience. The interview guide was based on that used in Article 3, but modified to fit the context of these care domains. The version was tested with a physician interviewee and modified prior to starting this study. Data was synthesized and analyzed using a comparative method for key concepts and patterns. A modified immersion/crystallization approach [259, 260] was used to review concepts against findings from our previous literature review and community based study. Theme saturation was achieved in the final interview. The study was given ethics approval on September 29, 2008 by the University of Alberta (File# B-180808).

Seven of 16 targeted physicians agreed to participate in this study. Three represented 3 city hospitals, 2 practiced primarily in urban family medicine centres, and 2 practiced primarily in academic settings. All physicians practiced in at least two of these settings. Six physicians had more than 20 years in practice. Four were paid on an alternative payment model, 3 interviewees were paid via FFS, and 2 had access to sessional pay for time spent buying an EMR.

3.4 Commentary

Article 4 [193] (published in ElectronicHealthcare) was developed using a completely different method. This article is a recount of the student's experiences in the development of the Alberta EHR. The article describes how failures in software operations produced adverse medical events which occurred during the development of the EHR. The article comments on the jurisdiction's adoption of a best of breed software operations management framework designed to mitigate the risk of future, similar adverse events. The article illustrates that software operations management is an emerging responsibility for policy makers and physicians alike as they adopt HIT. The case study illustrates how the adoption of HIT can help improve efficiency and reduce errors in the health system, but if not properly managed, can also cause its own issues. The lessons learned at the jurisdictional level are applicable to the adoption of HIT in the physician office.

3.5 Mixed Methods Study

Article 1 showed that telehealth could play a role in facilitating second opinion peer review in the pathology quality assurance process. During the development of the supporting research questions, we wanted to understand how telehealth technology supports the second opinion peer review process in primary care. Article 7 [227] reports on telehealth's role in specialist referral. Article 7 illustrates how telehealth combines with interdisciplinary teams to reduce wait times for dermatology referral while making the referral process easier for family physicians. The study hypothesized that asynchronous store-and-forward telehealth can reduce wait times for dermatological referral when supported by an interdisciplinary team. An Alberta PCN had created a Teledermatology Clinic to provide local consultation services to a community with no dermatologist. Upon consent, a brief patient interview was conducted by the clinic nurse following an interview guide. The interview guide (Appendix 4), consisting of open and closed-ended questions, was developed from key findings from a previous literature review [253] and tested with two non-patients prior to the study. Appointment durations were recorded by the clinic nurse. Administrative staff reviewed the clinic schedule to document the intervals between referral, first appointment and follow up appointment dates. Chart reviews were retrospectively conducted to determine reasons for referral. Referring family physicians were interviewed using a separate interview guide (Appendix 4) to gather information comparing their referral experience to the Clinic with their previous dermatology referral experience. Non-referring family physicians were surveyed by email (Appendix 4) to understand why they did not refer. Data was synthesized and analyzed from field notes using a comparative method to find key concepts and patterns. A modified immersion/crystallization approach [259, 260] reached theme saturation in the seventh interview. The clinic physician and the teledermatologist were interviewed to document their experiences. This study was given ethics approval by the University of Alberta on October 17, 2008 (File# B-190808).

Table 3-4 summarizes the results of the teledermatology study. Twenty three of the 28 patients had previous experience with conventional referral and were thus familiar with the referral process and wait times of many types of specialties. Seventeen of the patients said the Clinic had shorter wait time between date of referral and their first appointment at the Clinic and 13 patients described the Clinic as more convenient than their previous specialist experience. Seven of our patients were surprised (though not necessarily disappointed) to learn that the Clinic was not staffed by a dermatologist.

Table 3-4: Summary of Teledermatology Study Results

Study period	Sept. 1 to Dec. 31, 2008
No. of Patients Referred	28
Patient gender	16 female/12 male
Patient age	Avg. = 50 years, Std. dev. = 22.4 years
Primary Diagnoses	Keratoses, dermatitis, psoriasis, and nevi
No. of patients with previous specialist referral experience	23
No. of Referring Physicians	9
Referring physician clinical experience	10 to 35 years
Duration of initial appointment	Avg. = 15.2 min., Std. dev. = 5.5 min.
Interval from referral date to initial appt. date	Avg. = 6.9 days Std. dev. = 5.4 days
Interval from referral date through initial appt. to follow up appt. date	Avg. = 15 days Std. dev. = 5.8 days
No. of Non-referring Physicians surveyed	9

Although many patients were initially unfamiliar with telemedicine, only three commented on the equipment itself (expecting more sophisticated equipment). Twenty two patients were satisfied with the care received (using a three point Likert scale: satisfied, inconsequential and unsatisfied). Three patients said their satisfaction was contingent on positive outcomes of their care. The Teledermatology Clinic achieved a wait time of 6.9 days from referral to initial appointment. This compares to the average wait time of 4 days in a similar telemedicine study [261] conducted in the same jurisdiction. That same study found that average wait times for face-to-face consultation was 104 days (patients with emergent issues are triaged to be seen sooner). It is important to understand that our Clinic operates weekly, thus a shorter wait time could have been achieved although our dermatologist still required 24 hours to return diagnoses to the Clinic.

3.6 Patient Survey

Advanced access and HIT form a symbiotic relationship in facilitating primary care reform. As will be discussed in Chapter 6, advanced access can be used to improve access to primary care services. A solo family physician in Sherwood Park, Alberta, a community of 60,000 residents, recently implemented a simple online patient self-service appointment scheduling system. To understand more about self-service, we conducted a 3 part case study [254, 255, 256] to understand the how an online self-service appointment scheduling system could improve physician office capacity. The study hypothesized that some patients will book online for convenience while some patients will continue to book by phone for privacy reasons. Online booking may not be suitable for all patients as some will not have the computer skills or internet access. The study also hypothesized that there is an age and education dependent relationship with likelihood to book online. We interviewed the physician and staff using semi-structured interviews following an interview guideline with closed-ended, Likert scale and open-ended questions to gather the information. We also conducted a workflow analysis [254] of both the conventional telephone booking and online booking processes. Receptionist and physician interviews provided relevant background information. Receptionist observations were used to understand where the online booking process relieves staff from scheduling activities in favour of other duties [262]. The study contained a financial analysis of the system's cost structure [255] to determine its financial viability. Pricing mechanisms and marketing approaches used in the software industry were used to develop a mathematical model to calculate viability.

We surveyed patients [256] to understand more about their perspectives of the system itself and the concept of self-service in primary care. A 24-question patient survey using closed-ended, Likert scale and open-ended questions (tested prior to the study) was used to gather feedback from patients (Appendix 5). To be included in the study, patients had to be a registered patient of the physician and also had to agree that the physician was their primary care physician. Patients were included who booked by phone or online between Aug 8, 2008 and Feb 28, 2009. Patients were excluded if they had incomplete mailing addresses or were under the age of 18. Surveys were mailed out in groups of 500 surveys during the week of April 20, 2009. As long as patients returned their surveys in anonymous, self-addressed, stamped envelopes by May 31, 2009 they were included in our statistical analysis. This study was given ethics approval by the University of Alberta on March 20, 2009 (File # Pro00004173).

3.7 Professional Experience

The last strategy used to gather information for this program was through the work experience of the author. The author has had the good fortune of holding key positions at the centre of the health information agenda in the Alberta. The author entered the health system by taking a senior management role in the delivery of the Alberta EHR. As senior manager, the author had the opportunity to experience, lead and affect the EHR program. As a senior health executive in a PCN, the author experienced firsthand, the trials and tribulations of primary care reform. Work experience, articles and the studies described above have helped in answering this dissertation's research questions. There are many effects that information and computing technology brings to healthcare; too many to list exhaustively in one document. The following chapters describe a subset of the factors which have relevance in the Canadian health informatics arena.

It is important to understand how the author's professional and research contexts combine to facilitate these studies. The author is the General Manager of the

Sherwood Park – Strathcona County PCN. A PCN is a joint venture between a RHA and a non-profit corporation (NPC) that is formed by the physicians in the geographic area [67, 104]. In effect, the NPC is a legal entity which is operating as the PCN for the day-to-day activities of care delivery. Each of the physicians in Sherwood Park is a voting member of the NPC. Together, they vote to elect a Board of Directors which is responsible for directing the strategic aspects of the PCN. A primary task of the Board is to establish a Business Plan which documents all strategic expectations of the PCN. The Board then hires a General Manager, the author, who is responsible for implementing the Business Plan. The author, as General Manager, hires administrative and clinical staff to execute the Business Plan. The author, as General Manager, has no way of influencing the economic well-being of physicians. The General Manager does not assess performance of physicians, but rather, the General Manager's performance is assessed by physicians. Figure 3-4 summarizes the organizational structure [67, 104].

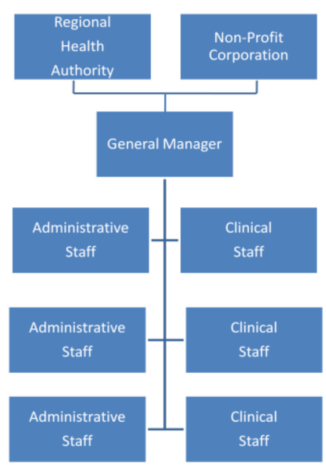

Figure 3-4: Primary Care Network Organizational Structure

3.8 Summary of Methods

Ten articles were produced and published (all of which have been accepted or published at this writing) in peer reviewed journals to share the findings of our studies. These papers were purposely researched with several different co-investigators to benefit the student from the research skills and interests of others. These papers were purposefully researched using several different methods to gain experience. The following summarizes the methods used in this PhD dissertation:

- Three articles used literature reviews to develop foundational knowledge regarding specific aspects of health informatics. Literature reviews extracted peer reviewed and grey literature from several literature databases, general practice journals, health informatics journals, medical journals, and popular media. Inclusion and exclusion criteria were used to screen articles for relevance. Unique articles which met criteria were critically appraised and then included in analysis. Where appropriate, the researcher contacted industry informants to gain information.
- Four articles leveraged semi-structured interviews of physicians, specialists and patients to gather information. Interviews followed a semi-structured interview guide developed from previous literature reviews. Interviewees were sampled using purposive, maximum variation and snowball sampling methods. Interviewees were screened with inclusion and exclusion criteria to ensure the data captured from them was relevant to the studies. Immersion and crystallization were used to distil interpretation from field notes. Ethics approval was received prior to the start of these studies.
- One article used engineering workflow analysis to understand the effect that information and computing technology had on physician office performance. Health system actors were observed and tasks recorded to map the workflow.
- One article used a patient survey and statistical analysis to understand patients' perspectives regarding self-service appointment scheduling. The survey instrument used open-ended, closed-ended and Likert scale questions to capture data from patients who met inclusion and exclusion criteria and who booked online and by phone during the study period. Surveys returned

to the researcher in anonymous, self-addressed, stamped envelopes by a specified date were included in analysis. Ethics approval was received prior to the start of this study.

- The researcher's work experience as a healthcare executive offered the opportunity to qualify research findings with industry context.

Chapter 4 – Socio-technical implications of ICT

4.1 Organizational Workflow

To deliver care, clinicians and administrators need to interact with each other, communicate with each other and work with each other. Healthcare is far too complex for any one person to carry out individually; rather it is necessarily a collective, cooperative venture [263]. The roles and tasks of physicians, nurses and other healthcare providers are tightly interwoven [263]. When organizations are young, few policies, procedures and workflows exist. The same task may be carried out in different ways from one circumstance to the next. The organization is inefficient. It is inconsistent. Quality of care may be unpredictable due to inconsistency in processes. Over time, clinicians learn to work with each, even socializing with each other as they provide care to patients. Through trial and error, ongoing interpersonal interaction develops into workflows and procedures. Workflow and procedures help make work predictable which contributes to quality. Eventually, the organization's environment, delivery experience, operating circumstances, workflow and procedures cause a mature organizational culture to materialize [264]. A mature organizational culture is the outcome of the very distinct and unique experience of that organization. A culture is a collection of the beliefs, norms, and values, spoken or unspoken that form the basis for the patterns of behaviours in the organization [265]. Since different organizations have different operational contexts, a wide range of practice approaches and possibilities may exist. Understanding the existing culture is critical to understanding how it will be affected by technology induced change.

The adoption of health informatics can have an enormous effect on organizational culture and workflow. Product managers (responsible for defining the strategic direction of the software product) collect feedback from many users whose experience is harvested to direct how software should operate and carry out its tasks. User feedback is critical to the requirements gathering and feature prioritization process and therefore, HIT is a projection of how a specific software firm and its users believe clinical tasks should be carried out. The software product represents how design engineers and their customers believe a clinic should manage its information. Interestingly, the collective experience of the users who provide feedback may be quite different from that of any one specific organization. Unless the software is custom developed specifically to fit the workflow of the target environment, its inherent workflow will likely differ from that of any customer organization [266]. The degree to which the workflow of the software matches the workflow and culture of the organization is referred to as the “fit”. The degree of fit, or better, the lack of fit, can have a significant effect on the operations of the clinic. The more the clinic has to change its processes to adapt to that of the software, the more disruption there will be.

Figure 4-1 provides a model to conceptualize this change management theorem. The horizontal axis in Figure 4-1 illustrates the infinite and continuous range of potential practice possibilities that a clinical work place may arrive at as a result of its environment, delivery experience and care circumstances. The vertical axis represents the socio-technical fitness for use of a specific piece of software. Customized software, designed for a specific target customer organization, will have a perfect fit with that organization’s workflow, producing maximum fitness for use. The fit between the software and the organization is high resulting in minimal disruption in existing workflow after adoption. Of course, a customized solution might be completely incompetent in a practice for which it was not designed. On the other hand, general purpose commercial of the shelf (COTS) software is one-size-fits-all software. It is software which attempts to be suitable for as many organizations as possible, but will not likely fit any one organization perfectly. The software has declining fitness of use if the actual organizational practice processes stray significantly from the target design (centre of the bell curve). Template and graphical user interface customization features allow some software products to increase their range of fitness for use, but such customizations obviously cannot cover the complete continuum of possible practice approaches.

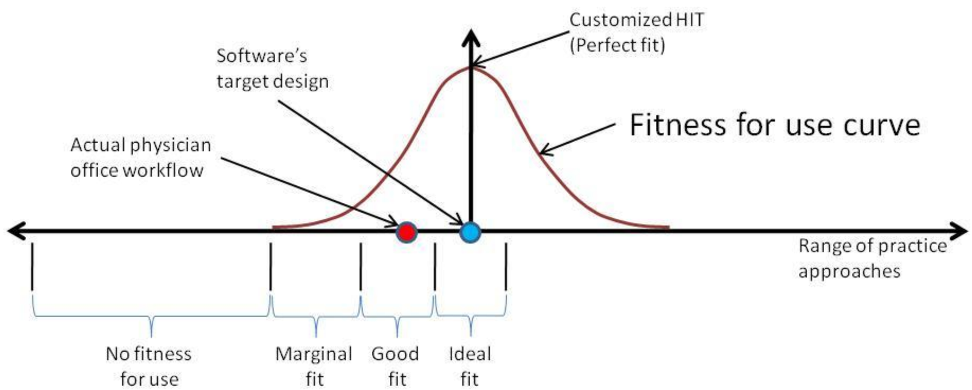

Figure 4-1 – Socio-technical fitness for use

The socio-technical dimension is one which suggests that the technical features of an information system and the social features of the work are fundamentally integrated [267]. There is a relationship between the tools that facilitate the healthcare processes and the interpersonal interactions needed to carry out the day-to-day clinical tasks of a care facility [160, 267, 268, 269]. In our recent literature review [253], socio-technical interactions between the technical features of a health information system and the social dynamics of a healthcare work environment were found to have the greatest impact on the systems implementation success [160, 267, 269]. Implementers must consider the system's "fit" within the culture and workflow [253] when selecting the software for their clinics. The difference between the organization's existing workflow and the workflow demanded by the system's technical features will drive change management forces, the strength of which will be proportional to the misfit between the two. Implementers must select a product whose fitness for use curve is highest for their actual practice.

Insufficient match between organizational workflow processes and new HIT software does not necessarily lead to an adverse implementation result. Sometimes organizational processes developed in isolation are inefficient or ineffective. Physician offices are notorious for being highly variable and inconsistent in their day to day practice [270, 271]. New software implementations provide an opportunity to review organizational processes, which may lead to overall improvement. Such efforts often uncover process inefficiencies [140, 160, 246, 268, 272, 273]. In this way, a change in clinic workflow can be seen as a positive outcome, as long as the technology being implemented is built on well-founded, clinical design input from physicians which realizes improvements in workflow. New software implementations challenge clinicians to build a collective understanding of their processes so that all stakeholders have a common understanding of them. Organizational stakeholders may then understand how a new system will fit [169, 274, 275, 276]. In large system implementations, health information system implementations become “a process of mutual transformation of the technology and the organization” [263]. Hospital implementations can often be customized by system integrators contracted by the hospital to make modifications to suit hospital workflow needs. In primary care, physician offices do not have the buying power to command changes to the software which would result in a better fit with existing practice processes. Instead, the process of transformation is more one-sided, requiring the practice to transform to fit the software. Certification organizations, discussed later in this dissertation, ensure that the technology being selected and implemented best fits the collective need of primary care physicians. Regardless of whether change yields process improvements, misfit can result in temporary uncoordinated processes and disruption which may manifest itself in the form of any number of risks.

4.2 Risk Factors to Successful HIT Implementation

As would be expected, the goal of software implementation project is to realize implementation success – illustrated as the centre of the model shown in Figure 4-2.

Implementation success might be defined differently for individual organizational circumstances. Some clinics may wish to simply transition to electronic records to permit remote access by the physician from home or by a geographically distributed team [277]. Some clinics may be interested in leveraging their interdisciplinary team members more effectively. Others may be seeking the benefits of clinical decision support tools to improve healthcare quality assurance. Clearly, socio-technical factors have a direct impact on implementation success. Figure 4-2 illustrates a number of risk factors which must be managed to ensure the goals of the project are achieved.

Our international literature review found socio-technical factors to have the greatest effect on HIT implementation success, and therefore, Figure 4-2 shows a socio-technical ring directly adjacent and immediately surrounding the project goal. To protect against socio-technical conflicts, implementers must carry out a significant amount of product investigation to ensure process fit is maximized. Socio-technical requirements gathering is a technique designed specifically to understand the requirements of a dynamic organization. Traditional requirements gathering assumes the problem domain is stable, known and fully available [267]. Regrettably, healthcare is anything but these. Clinical work is highly collaborative, cooperative and is characterized by a constant stream of exceptions and contingencies that modify the main stream workflow [263]. Socio-technical requirements gathering is recommended over traditional methods because it embraces the social, political, organizational and cultural personality of the organization [140, 267, 278]. It is an iterative process which employs a qualitative approach to determine how the technical requirements of the system fit into the operational, organizational and cultural processes used to provide care. Where there is poor fit, either the health information system, the workflow or both must be modified to optimize fit. Physicians need to gather product information, analyze their own clinic processes and evaluate the available products against their needs to select the best product for their clinics. Chapter 5 discusses how jurisdictions can support their physicians in making wise system choices.

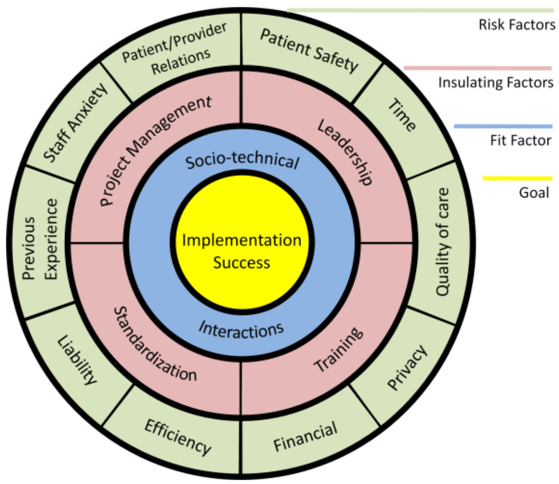

Figure 4-2 – Insulating and Risk Factors of HIT Implementations

If the socio-technical factors can directly affect implementation success, then the factors shown in the outer-most ring represent environmental risk factors which, if left unmanaged, can complicate or compromise the implementation. These risks cause uncertainty when transitioning from the pre-existing workflow to the workflow which exists post-transition. Privacy [279], patient safety [150, 151, 173, 174, 280], provider-patient relations, staff anxiety [160], time needed to implement [199, 278, 281, 282, 283], quality of care, financial [184, 284, 285], efficiency, and liability [140, 227, 258] factors are risks that must be managed for implementation success.

Some narrative reviews have reported that new implementations sometimes become a source of anxiety and aggravation to staff. Staff anxiety is stimulated by changes to long established processes, increased dependence on computer systems [286, 287], eroded capacity for decision making [160], perceived increases in levels of accountability to clinicians doing order entry [288] and concerns that new health information systems would affect the provider-patient relationship [140, 289].

Articles reported resistance to change by staff, especially when change was thrust upon them [290, 291]. Various predictable and unpredictable positive and negative behaviours were reported as a result [269, 289].

Articles recommended proactively addressing staff concerns and including staff in projects as a means to manage resistance [167, 171, 246, 273, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303]. Sometimes office staff have a better understanding of how new technology can be used to improve workflow. Even though physicians own and run their clinics, their staff may have perspectives which offer a different view on office operations [273, 277]. Furthermore, different members of the workforce bring different perspectives and skills to the implementation [273, 304]. Staff need to feel that they can contribute and have control over their future. When an organization undergoes significant organizational change, physician leaders might encourage individuals to bring their contributions to the project. By leaving room for team members to contribute, project leaders benefit from the rich experience of others. Team members get a chance to influence the implications of upcoming change and to contribute to their development. Team members from different parts of the organizations may hold valuable information which may enrich a new process or system. The implementation is richer for their input and stakeholders have more buy-in to the outcomes of the project.

Implementers have a great deal of concern about the privacy implications of adopting electronic systems. Some physicians and patients may feel that information thieves may infiltrate their office networks to steal their patient data. Privacy policy and health information acts make physicians directly responsible for the privacy of their data [305], and so naturally, physicians would have these concerns. Implementers should note that paper based systems also have their privacy challenges [183]. HIT simply presents different privacy challenges. Liability has proven to be another significant concern for physicians. In our early studies of telepathology systems, a leading factor slowing its adoption was pathologists' concerns about their liability for diagnoses made remotely [228, 230]. A similar concern was uncovered in our international literature review. Liability concerns materialized again when studying the role teledermatology can play in facilitating specialist referral [227]. Later in this dissertation, we will examine how certification processes can address liability concerns. The dissertation will also address how HIT can affect the provider-patient relationship, time needed to implement systems, time to deliver care, quality of care, efficiency and financial factors.

Obviously, there are many factors that can derail an HIT project. If physician adopters are to realize its benefits, they must be prepared to follow a number of risk mitigation approaches. The insulating ring shown in the target model is inserted between the risk factors and the socio-technical factors to symbolize how they protect the implementation and ensure it meets its objectives. Strong physician leadership [171, 246, 278, 295, 306, 307, 308, 309], project management [272, 273, 275, 280, 293, 295, 306, 310, 311, 312], standards and staff training [167, 171, 199, 278, 281, 282, 283, 303, 307, 309, 310, 313, 314, 315, 316] lead to long term adoption. Physician leadership is absolutely critical to any health project, but especially one that changes how healthcare is delivered. It is an important pre-condition for effective implementation of a project [317, 318]. Leaders declare support for an initiative, show it to be a priority and ensure adequate time and resources are available for implementation [319, 320, 321]. Leaders' attitudes and practices have significant influence on an organization's culture. Physician champions are specifically valuable when the project encounters roadblocks – especially roadblocks put up by other physicians. In these circumstances, physician leaders need to have a clear vision for outcomes and benefits of the project. They need to be able to see over obstacles to the goal. When they encounter resistance from colleagues they need to be able to respond in an engaging fashion using their courage and social skills [265].

4.3 Implications of Socio-technical Factors on Physician Office Performance

Unless there is perfect socio-technical fit, an HIT project will precipitate process changes that will result in destabilization of workflow processes as the new system is absorbed into the organization's culture [150, 151]. If the software requires the organization to "transform" its workflow processes, staff may become disoriented. Disorientation may lead to miscommunication and poor coordination of activities. When workflow changes compromise organizational predictability, misdiagnosis or mistreatment may result and quality of care may be compromised. The more socio-technical conflict between pre-transition workflow and that required to operate the software, the more likely patient safety will be compromised. Clearly, the health information systems themselves are not the source of adverse medical events, but rather the processes around the systems permit errors. Studies have showed that error sources resolved down to training issues, implementation issues, and the time needed to become accustomed to the system [199, 278, 281, 282, 283]. Studies found in our international literature review provided advice on how to mitigate errors. Solid training, bar-coding systems, pilots and strong IT management were tools purported to minimize errors [322]. Authors advocated that quality of care and implementation success could be improved and errors minimized by establishing standardized terminology and lab test results ranges [167, 292, 315, 316]. However, standards themselves are insufficient. Testing and software quality assurance (as opposed to clinical quality assurance) is required to ensure that software is properly engineered to the established standards – a process reviewed in Chapter 5.

After an implementation, it takes time for workflow process to restabilize around the new tools in the care process. This restabilization time can be affected by the nature of the transition itself. The literature refers to two extremes in implementation approach [310]. A "big bang" approach installs the system quickly and requires users to use the system immediately. Oppositely, 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 [323]. An incremental project approach is recommended for large organizations with complex processes, with complex organizational cultures or powerful political structures [310, 324, 325] because it permits time to adapt to the change.

Figures 4-3 and 4-4 illustrate how these two extremes might affect clinical operations, using patient volume as example. Regardless of which implementation approach is used, prior to implementing a new information system, the clinic will be at a pre-transition steady state of patient throughput (the line leading up to Point A below). The steady state exists when various forces which effect volume are in equilibrium. For example, in a fee-for-service environment, upward pressure is applied by the remuneration system, which incents maximum volume throughput. Additionally, physicians may be pressured to maximize patient throughput when they have a waiting rooms full of patients. On the other hand, downward pressure exists because of the amount of time it takes to provide quality healthcare. It takes time to understand the patient's complaint, perform investigations, make a decision and then take any necessary interventions. Patients also wish to develop a relationship with their physicians, which takes time to develop in the encounter. Complex patients, such as those suffering from chronic diseases, take more time than those suffering from a cold or broken arm.

In a big-bang implementation (Figure 4-3), the speed of the implementation is much faster than the rate at which users learn to use the software. The implementation is also faster than the culture's ability to absorb the changes in work process implied by the new system. As a result, in the first few hours and days after "go-live" (illustrated by Point A), patient volumes may fall as confusion and miscommunication permeate [167, 169, 170, 171, 296, 303]. Adverse effects tend to materialize and outweigh positive outcomes in the period shortly after implementation [150, 326]. The difference ($\triangle PV_{Pre}$) between pre-transition steady state patient volumes and the low point (illustrated by Point B) in patient throughput can be quite large. Keshavjee et al. estimated that throughput decreased by 33% [327]. Our interviews suggested depressed volumes may persist for a significant period [78, 161]. Slope of the destabilization trend (line AB) is a function of the speed of the implementation as well as the fit between new system and pre-existing workflow. The greater the implementation speed, or the greater the degree of misfit, the greater the slope of AB. The radius of the curve at Point A shows that it takes time to implement a system [167, 169, 170, 171] – even big-bang implementations are not instantaneous (which would result in an immediate transition into the slope of line AB).

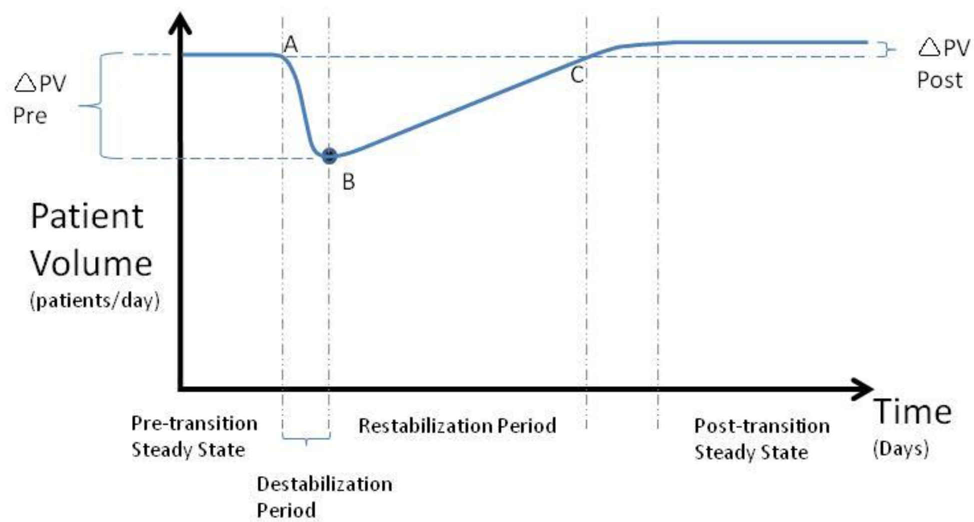

Figure 4-3 – Transition effects on patient volume – Big-bang approach

Recovery begins when project leaders realize the workflow changes (the transformation referred to by Berg [263]) needed to integrate the new system into the organization (line BC). Restabilization occurs as the organization starts to relearn its workflow in the context of new information management tools. Implementers should be warned that this part of the adoption experience is an "unpredictable social process that transforms both technology and practice" [280, 328, 329]. Keshavjee reported that the destabilization period plus the restabilization period took 18 months to return to original performance levels [327]. The rate of restabilization is a function of physician computer skills, exam room layouts, the complexity of the graphical user interface, technical implementation issues and the amount of training available [253]. Brown [280] suggests that this rate can be increased if the software can be configured to better match the workflow of the clinic, which is consistent with the model described by Figure 4-1. Standards can help to improve restabilization by establishing agreement regarding how the technology should be used. Standards, established during requirements gathering and solidified during training, ensure that all clinicians are using the technology in the same way. Standardization helps to re-establish workflow processes, predictability, consistency and quality.

If the big bang approach causes change to occur too quickly, the incremental approach may offer an alternative. An incremental deployment approach offers a smoother transition to a physician office system. In a planned, incremental approach, changes are made one at a time so that users can learn the new software at their own pace. The rate of destabilization (slope of line AB) shown in Figure 4-4 is not as dramatic. Point B at which clinic performance starts to restabilize is not as deep, although it may occur later than would be experienced under a big bang approach. Restabilization may occur sooner (Point C). A measured approach to change allows clinicians and administrative staff to adjust to one change without being confused by the impact of another [140, 272, 273, 275, 276]. Organizations are more likely to see implementation success when focusing on one important change at a time [330, 331, 332]. An incremental project approach was recommended for large organizations with complex processes, with complex organizational cultures or powerful political structures [293, 310, 324, 325] because it permits time to adapt to the change. An incremental approach is particularly suitable for large organizations (large physician offices or hospitals) which require a great deal of change coordination. Organizations with complex workflows may need to take more time to redesign workflow in the light of changes brought forward by HIT. The incremental approach is not a panacea. It can be slower. Double data entry in a pre-existing system (such as paper or a previous electronic health information system) and a new system is often required for an extended period of time, which adds to cost and user inefficiency. Smaller physician offices do not have the time for double data entry and generally follow a big bang approach [78, 161]. Larger physician offices can afford project management resources which facilitate an incremental approach [78]. Interestingly, some physicians have even reported the incremental approach to be too slow [78].

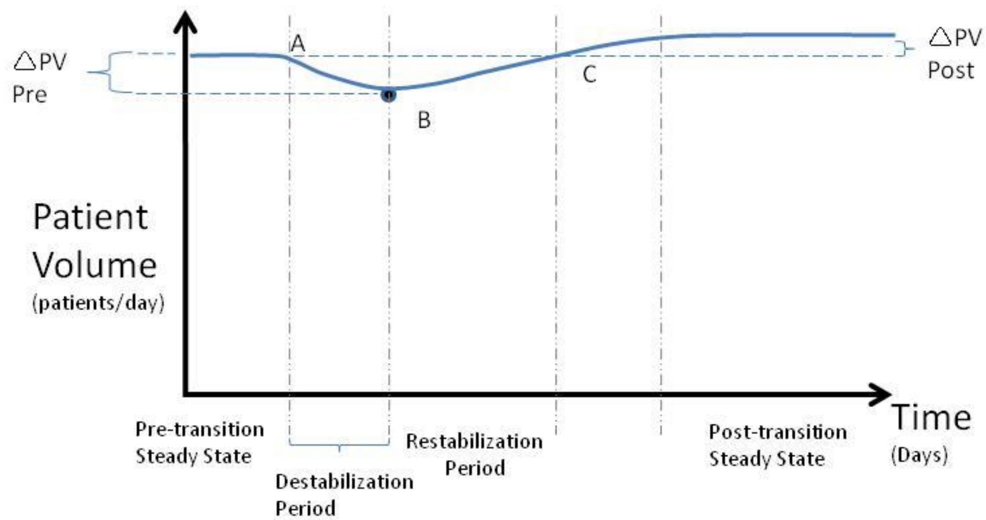

Figure 4-4 – Transition effects on patient volume – Incremental approach

Some HIT advocates suggest that one benefit of HIT adoption is an increase in patient throughput due to office efficiencies. Figures 4-3 and 4-4 display this as post-transition patient volumes which settle out at higher levels than pre-transition volumes ($\triangle PV_{Post} > 0$). The literature, and our experience, would indicate that it is unclear as to whether post-transition patient volume is greater or less than pre-transition volumes. Some clinicians believed it would take them longer to complete clinical activities after implementation, resulting in lower post-transition patient volumes. However, some time and motion analyses found that there was a slight decrease [323, 333, 334] in the time taken for common clinical documentation activities once the team was proficient with the system. The decrease could potentially result in an improvement in $\triangle PV_{Post}$. Other studies showed an increase in physician time for documentation offset by time savings in other areas of the clinical process [333, 335, 336]. In one case where a time saving was encountered, the saving was put back into the encounter time for more patient care tasks [334]. Rodriguez et al. [335] found no difference in overall time to complete typical physician tasks. Another study concluded that little to no extra physician time was required to use computerized order entry [336]. McGrath's study showed that those physicians who make greater use of EMRs in patient encounters have longer appointments than those who do not [337]. Overhage et al. [338] found that physician order entry time initially increased with the adoption of a CPOE system, but showed improvement with experience. In our own studies, physicians suggested that HIT could improve their office efficiency and patient throughput which would cause the post-transition patient volume to reach equilibrium at a higher volume. Some physicians have qualitatively estimated as much savings as 40 minutes per day which has been realized from time savings in reviewing lab test results [172, 339]. However, physicians' computer skills and the office layout compromised any efficiency gains [78, 161]. Later, this chapter examines how office layouts affect the information transfer between patient and provider. An area for further study could be to assess the effects of HIT on patient volumes in the long term and the associated affects on waitlists.

A simple factor, still requiring discussion, is the effect that data conversion has on the transition experience described above. Much of the factors described above apply to physician offices whether they are converting from a paper records system to an electronic system or from one electronic records system to another electronic records system. Regardless of the circumstances, the data conversion process offers another source of friction which serves to slow the transition from one system to the next. If a physician is converting from a paper based records system, conversion implies a manual process to get records into the new electronic records system. Physicians are advised to convert their paper data only as patients present to their clinic [340]. Some patients may never present again in the future, and so converting their records unnecessarily would be a waste of resources. Hand typing lab test results and diagnostic imaging text reports (DITRs) as well as scanning reports are a few options. Some PCNs offer financial support to physician offices to encourage such services to be used [341]. Scanned reports can't be searched, but at least the data can be made available to more physicians.

A similar process also applies for physicians converting from one electronic system to another. Currently, the vendors of different physician office system products offer very little compatibility between applications. Database formats and schemas are completely different because there is no collaboration on database development or on a minimum data set for what physician office system databases should contain. There are some data fields from one vendor product which may not be congruent or even exist in another product. Reminiscent of the comparison between Microsoft Word and Corel WordPerfect, many databases are built on proprietary formats. Some are SQL based. Some have available drivers, but others have not been made available by preference of the vendor. For the most part, vendors are reluctant to publish their database schemas because they do not wish to facilitate conversion away from their product. As a result, physicians converting from one electronic health information system to another electronic solution are effectively in the same circumstance as a physician converting from paper. Physicians should only convert what is needed, as it is needed; which, unfortunately, implies that the old system and the new system must be used at the same time for a transition period. When a patient presents, administrative staff look them up in the old system and manually transfer data to the new system as needed. Only summaries are transferred into the new system. As more and more patients continue to rotate through the physician office, their past health history becomes less and less important and so over the course of 18 months or so (the time needed for most of the patient panel to visit the clinic), health data for the active portion of the patient panel will be transferred into the new records system. Since many physicians were already operating on electronic medical records in Alberta [215], Alberta is faced with having to facilitate the electronic to electronic conversion process for many physicians. Alberta recently awarded a contract to a consulting firm to develop conversion tools to help quicken this transition for physician offices [342].

4.4 Human Factors Design

Human factors play a more direct role in the healthcare delivery process that occurs within the physician exam room. In the context of the urgency inspired by a fee-for-service remuneration model and waiting times, exam room designs, complexity in graphical user interface, and physician computer skills had an effect on the physician-patient encounter. These elements combine to provide both supportive and, at the same time, obstructive effects on care delivery. Efficient patient encounters (face-to-face time with a physician is sometimes referred to as “red zone time”) are important to maximizing patient throughput, delivering quality of care, addressing wait times and meeting demand for care. A daisy chain of benefits falls out of efficient patient encounters. The shorter the wait times, the more likely patients are to see their own physician, which further translates to continuity of care, quality of care and other efficiencies. Primary care HIT has caused significant changes to the nature of the patient-provider encounter.

The medical encounter is the fundamental element in the provision of healthcare [343, 344]. There is a difference between how patients communicate their medical problems and how physicians listen and interpret patient complaints. The disease model guides the way physicians capture patient data. Physicians tend to represent and collect medical problems in terms of biomedical phenomena. Their training leads them to think in terms of the biomedical systems and the interferences that are causing the patient to feel illness. Patients, on the other hand, present information in terms of a narrative structure that describes their illness in the context of their life [344]. Successful communication between the doctor and the patient requires more congruence between the physician’s disease model and the patient’s illness model. A better understanding of the patient’s perspective on his or her illness may benefit physician–patient communication, ultimately resulting in patient's compliance with treatment directives [344, 345]. Communication is especially important in primary care and specifically in the management of chronic disease [343] where better physician-patient communications lead to better health outcomes [346, 347, 348]. Yet, the above differences can combine to obstruct communication.

Mehrabian [349] suggests that as much as 55% of interpersonal communication occurs through non-verbal channels. There are several modes of non-verbal communications [337, 350]:

- Kinesics: visual bodily movements, gestures, facial expressions, posture, gait, gaze
- Vocalics: use of vocal cues, such as pitch, loudness, tempo, pauses and inflection
- Physical appearance: clothing, hairstyle, cosmetics, fragrances
- Haptics: use of touch, including frequency, intensity, type
- Proxemics: interpersonal distance and spatial orientation
- Chronemics: use of time as a message system, such as waiting time, lead time, amount of time spent with someone
- Artifacts: objects and environmental features that may convey messages

Information exchange is enhanced when physicians listen, provide health education, and summarize patient statements [343]. Nonverbal skills have been associated with outcomes such as patient satisfaction, patient recall of medical information, compliance with keeping appointments and compliance with medical advice [337, 351]. Lack of eye contact has been associated with less patient disclosure [337]. Physicians who have more direct patient-directed gaze achieve higher patient satisfaction [351] and are more accurate at recognizing the patient's degree of psychosocial distress [326, 337, 352]. Physicians using EMRs in the exam room tend to clarify information by asking questions to ensure the completeness of records

[337, 352]. However, EMRs can shift physicians' attention away from the patient and can compromise their ability to communicate non-verbally. Gesturing and expressive body movements become difficult when physicians' hands are anchored to a keyboard. There are several sources of distraction which we explored in a series of semi-structured physician interviews [161]. Our interviews, informed by exam room observations, showed that physicians must orient themselves to the computer if they are going to perform data entry. Our study found that 11 out of 19 rooms viewed required physicians to face away from patients when documenting the information from the patient [161] (Figures 4-5, 4-6, 4-7). Our figures below attempt to simplify and categorize the rooms that we saw into three types based on the type and placement of furniture (artifacts), the type and placement of the computer monitor, as well as the positioning of the physician with respect to the patient (proxemics and kinesics) [161]. Angle A, created between the two lines of sight from the physician to their computer monitor and the physician to the patient, become critical to the non-verbal information transfer and the successful transmission of data. McGrath noticed that kinesics, artifacts and proxemics worked together to produce a noticeable difference in patient-provider nonverbal communication [337]. Other studies showed that eye contact becomes extremely difficult when entering data [352]. Clinicians with good paper-based data gathering and recording skills tended to translate that skill to computer based recording [351]; however, there is still a limit to the amount of concurrent tasks that any person can successfully carry out at one time (When as few as two tasks are performed in parallel, people focus most on one task [352]).

Exam room computers could have an effect on provider-patient communication by changing the verbal, visual and postural connection between patients and clinicians [351]. These effects can be mitigated by considering the placement of the computer monitor relevant to the patient and physician. Obviously placing the computer such that the physician can see the screen and the patient (Angle A < 90 degrees) is a step in the right direction (Figure 4-5 below). However, this approach may be easier said than done. In our study, we noticed that several physicians had been practicing in the same office for many years, long before the advent of computing technology in business [161]. Optimally orienting the computer monitor to the patient and physician would, in some cases, require office renovations which would incapacitate the office for several days and cost several thousands of dollars. Renovations become another barrier to EMR adoption in such cases. In general, issues pertaining to exam room layouts, kinesics and proxemics are unseen obstructions which tend to lengthen the restabilization period described previously.

Still, there are other, maybe simpler, solutions which might facilitate adoption in the near term. Using portable wireless computers would help improve the alignment of the physician to the patient during data gathering. Physicians place the laptop on their lap to look directly over the screen to the patient (Angle A = 0 degrees) [161, 353]. This would mimic the proxemics that are present when physicians use paper note taking systems as opposed to an electronic information management system. Laptops can be easily spun around to allow the patient to view the screen to participate in the data gathering, and confirm that the information is recorded accurately (though the privacy implications of a wireless network need to be considered through a privacy impact assessment).

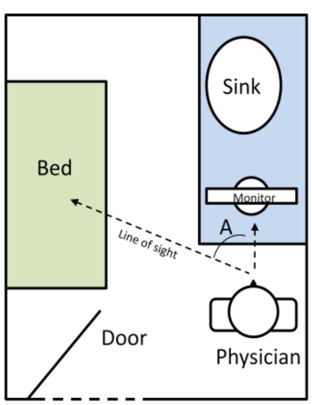

Figure 4-5 – Exam Room Layout 1

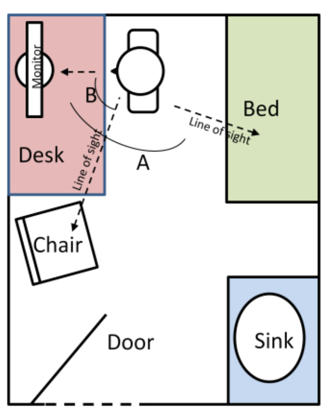

Figure 4-6 – Exam Room Layout 2

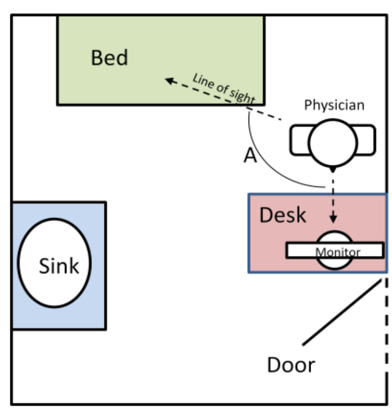

Figure 4-7 – Exam Room Layout 3

Exam room designs, proxemics and kinesics are not the only human factors that have an effect on the healthcare patient encounter. A relationship also exists between the software graphical user interface and physicians computer skills. Human factors such as product usability, process complexity, and user-engagement methods routinely influence IT systems uptake [354]. The clinician's ability to navigate on the computer is another factor that influences whether its use during a visit facilitated or impeded communication [351]. Some studies found that previous familiarity with computers, EMRs and computer confidence affected uptake and short term productivity [253, 326]. Our physicians self-reported their computer skills rated at 3, on a scale of 1 to 5. Similarly, a US survey [355] reported that their physician survey respondents felt quite confident about their computer skills. We did not observe physicians using their EMR for note taking during patient encounters; however, considering the complaints physicians had about the usability of basic computer functions suggests that physicians, vendors and HIT advocates have underestimated the level of computer skills required for this work (Physicians reported that they hunt for menus and buttons to the extent they sometimes stop using the EMR in interviews because of the disruption). EMR user interfaces are complex and busy (reminiscent of an airplane cockpit). "The skills needed to listen to patients' complaints, assess medical relevance, contemplate interventions as well as type notes – all at the same time – would require a significant level of concentration, typing skills and familiarity with the application's user interface, not normally found in the most adept computer users" [161]. Therefore, we were not surprised to learn that physicians often had to complete note taking after the encounter or at the end of the business day [78, 161].

Some physicians were concerned about patients' perception of their novice computer skills [78]. Interestingly, physicians purposefully developed ways of including patients in note taking. Some learned to type while making eye contact with the patient. The approach necessitated strong typing skills and computer/desk arrangements which allowed Angle A to be acute [78, 161]. Some learned to make audible (non-verbal) cues to patients to let patients know physicians were still listening. Some physicians turned the monitor to face the patient so the patient saw what was being typed [78]. One physician listened to his patients first and then verbally repeated back what was said by the patient, while typing at the same time, so that the patient could verify the accuracy of the physician's interpretation of the condition. Some physicians printed out reports or flow sheets for patients to take home [78]. All of these approaches shorten the restabilization period, allowing the physician office to return to pre-transition patient volumes sooner.

4.5 Financial Implications of Socio-technical Factors

Physicians must address several cost factors when considering HIT adoption. There is the cost of the software, the cost of physician time spent investigating and evaluating software, and cost of training. These costs are relatively concrete and identifiable, and some of them are reimbursable, as will be reviewed in Chapter 5. There is also an opportunity cost represented by a temporary reduction in patient volumes in a fee-for-service remuneration model. If the post-transition patient volumes are no greater than the pre-transition patient volumes, then an unrecoverable opportunity cost exists due to the transition. The area in triangle ABC in Figure 4-8 illustrates the lost revenue generating opportunity that a clinic endures when implementing new HIT. If the post-transition patient volumes exceed the pre-transition patient volumes ($\triangle PV_{Post} > 0$), an opportunity for cost recovery exists. Greater post-transition volumes are an incremental increase in remuneration in a fee-for-service remuneration model. The rectangle formed by the post-transition change in patient volumes (Figure 4-8) represents incremental volumes which can be used to recover lost opportunity costs due to the temporary reduction in patient volumes. Costs of investigation, evaluation, hardware and software are often reimbursable under several jurisdictions' certification programs, and so these costs need not be considered in cost recovery.

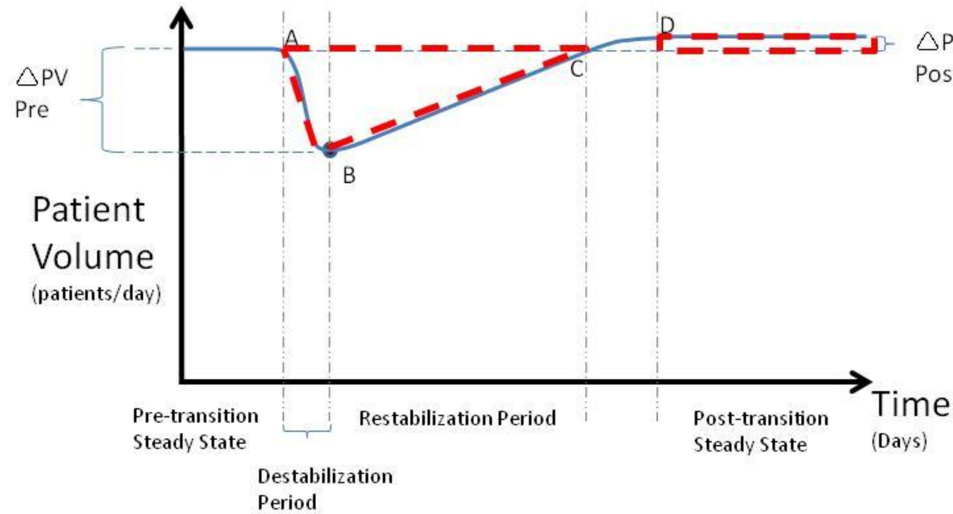

Figure 4-8: The opportunity cost of transition

For a practice with known average billing rate per day and number of patient visits per day prior to implementation, then the triangle ABC can be used to calculate the lost opportunity cost represented by the HIT transition itself. Point A is the go-live date on which the organization commits to transition to the new HIT. The number of days between Point A and Point C represents the destabilization and restabilization periods combined. The destabilization period is the number of days between the "go-live" date and the date on which the lowest patient volume, due to implementation, occurs. The restabilization period occurs between the date when the lowest patient volume occurs and the date on which the patient volume has recovered to the steady-state patient volume prior to the implementation. Put another way, the destabilization period plus the restabilization period occurs from the "go-live" date to the date by which patient volumes have recovered to their pre-transition levels. Point B is determined when the lowest patient volume is achieved due to the disruption caused by the change. Equation (1) calculates the area within the triangle ABC and represents the cost of the transition itself. Equation (1) does not require the date at Point B because it uses the simple formula for calculating the area of a triangle (1/2 x base x height). The destabilization and restabilization periods are measured in units of time (days). The average billings must also be based on the same units of time. $\triangle PV_{Pre}$ is the decline in daily patient volume from pre-transition steady state before starting restabilization.

$$\text{Cost of transition} = ½ \times (\text{Destabilization Period} + \text{Restabilization Period}) \times \text{Avg billings per patient} \times \triangle PV_{Pre} \quad (1)$$

By way of example only, Equation (1) helps us calculate the basic lost opportunity cost using the statistics reported by Keshavjee. Keshavjee reported that patient volumes fell by 33% and that it took 18 months to recover to pre-transition patient volumes. Applying these statistics to an Alberta physician who typically sees a new patient every 15 minutes over an 8 hour working day and who receives roughly $30 per basic (non-complex) visit, we can determine that the cost of transition is roughly $28500 (1/2 x 180 days x (32 patients per day x $30 per patient visit) x 0.33). It is no wonder that, left to their own devices, physicians would not see the value in selecting health information technology [184, 285, 356].

If the physician office enjoys higher post-transition patient volumes, then an opportunity for cost recovery exists. We can calculate a payback period over which lost revenue is recovered by matching the size of triangle ABC to the rectangle created by the incremental increase in patient volume multiplied by the base of the rectangle (measured in units of time such as days) illustrated in Figure 4-8. Equation (2) calculates the number of days after reaching Point D that the system will require to pay for itself through the incremental increase in patient volume ($\triangle PV_{Post}$ is incremental increase in daily patient volume after restabilization is complete. It is assumed to be negligible from Point C to Point D in Figure 4-8).

Using our example data, we can determine the amount of time needed to recover the lost opportunity cost. For purposes of illustration we arbitrarily assume that patient volume is increased by 10%. If this is the case, then Equation (2) illustrates that it would take 297 days after restabilization is complete to recover the cost of transition (1/2 x 180 days x 0.33 / 0.1).

$$\text{Payback Period} = \frac{\frac{1}{2} \times (\text{Destabilization Period} + \text{Restabilization Period}) \times \triangle PV_{Pre}}{\triangle PV_{Post}} \quad (2)$$

Several assumptions must be made for this model to work. First, we assume that any change in patient throughput is entirely due to transition to a new system and not related to any other simultaneous changes. The practicality of this assumption will depend on the circumstances of the organization in question. Han showed that concurrent workflow changes can play havoc with process and patient throughput [150]. Multiple concomitant changes aggravate the work environment and can lead to complications [150, 269, 357]. Although the "go-live" date (Point A) can be quite clear, Point B may be difficult to establish due to fluctuations in the daily patient volume. Such fluctuations may relate to the absorption of new workflow into the organization's culture, but may also be due to other external, unrelated and uncontrollable factors. The model assumes the destabilization rate and restabilization rates are relatively uniform (linear). This may not always be entirely accurate as learning curves of clinicians may not be linear. Exam rooms may be renovated to make the encounter more productive. Graphical user interfaces may be updated to become easier to use. Training users on the EMR or typing skills may alter the restabilization rate. The model assumes that Point B is a distinct point in time rather than a prolonged period of time better represented as a curve or line over which patient volume remains depressed. This assumption may not apply in every case. Instead of a nice, tidy, distinct turning point illustrated by Point B, physician offices may experience a prolonged period of time of low patient volumes due to their limited capacity to see patients when working through organizational change. Point C, the date on which patient volumes recover to pre-transition volumes, may not be easy to establish. The clinic's patient throughput may oscillate around a target level for many weeks before settling out. Of course, we may also not be able to assume that Point C, the point at which post-transition steady state patient volumes begins, is at the same level as Point A. It is quite possible that post-transition patient volumes stabilize at lower rates than pre-transition volumes (i.e., $\triangle PV_{Post} < 0$). As we found in our interviews, it is rare that patient volumes increased after implementation [323, 333, 334], and even if they did, some physicians consciously chose not to increase patient throughput but opted for a more leisurely, quality experience for them and their patients [78]. New Zealand claims GPs can save as much as 30 minutes a day as a result of benefits from HIT adoption, but such claims are anecdotal [63].

4.6 Quality in Healthcare

The Institute of Medicine [130], Davies et al. [145], Wilson et al. [146] and Baker et al. [147] have reported staggering and disturbing figures about errors occurring in health systems around the world. Patient safety and quality of care have become high priorities in the healthcare delivery. HIT certainly has a number of features with the potential to improve quality and safety [143, 167, 168, 303, 358]. A recent systematic review conducted for the Agency for Healthcare Research and Quality found that HIT systems can increase the delivery of guideline-adherent care, improve quality of care through clinical monitoring, and reduce rates of medical errors [358]. Computer-assisted diagnosis and care management programs can improve clinical decision making and adherence to clinical guidelines, improving the focus on patients [143]. Features such as clinical decision support, contraindication management, order entry, and results management improve quality of care because they support the clinician in decision making. Clinical decision support tools prompt clinician activity, which is especially helpful in busy, chaotic care places such as emergency departments of pediatric wards [359]. Contraindication management is a feature that checks previously prescribed drugs with ones about to be prescribed to see if there are any conflicts (adverse reactions, toxicity, etc). Contraindications can also exist between patients' allergies and drugs. Order entry is a feature that simply uses electronic means to record and send drug orders or diagnostic tests (lab tests or imaging) to the dispensary, lab or x-ray department. Results management is the ability to see and consider the results of tests, allowing for quicker recognition and treatment of medical problems [143].

Is there a role for HIT in improving quality and safety of patient care? There are several ways in which HIT facilitates quality improvement, but there are also ways in which HIT can cause errors. Peer review is a form of quality assurance. Peer review occurs when one clinician asks another clinician to review the evidence for a diagnosis. HIT can facilitate peer review prior to intervention by sharing the evidence between clinicians. Second opinion is another form of healthcare quality assurance. Telepathology facilitates second opinion consultation to an external or consultant pathologist by providing a method of easy, rapid and inexpensive transport to the consultant pathologist [230]. Conventionally, when a second opinion is sought, the slides are sent along with a letter and patient demographics to the consultant pathologist. Manual handling presents the opportunity for several failure modes [230]. Instead, both real-time or store and forward telepathology could be used to send electronic images of slides to a remote pathology consultant who can provide their opinion and return the diagnosis. Errors resulting from accession in laboratories, handling or mislabelling clinical data are reduced [230]. Access to remote diagnostic opinion might be particularly relevant in geographic areas where no pathologist is available.

A similar experience is seen in primary care when a general practitioner makes a referral to a specialist. Specialist referral can be an onerous process for physician offices. Staff may make several attempts to fax or call in referral requests. Continued and repeated handling can result in referrals for incorrect patients or diagnoses. Earlier we discussed how store and forward teledermatology could be used to send history and diagnostic information to a dermatologist for asynchronous consultation [227]. A centralized teledermatology clinic staffed by an interdisciplinary team illustrated how a store and forward teledermatology system could facilitate safe, effective and fast dermatology referral. Transferring patient identification, health and demographic data electronically minimized opportunity for handling error. Physicians' confidence in the clinic's processes, the ease of the referral process and the fast report turnaround times offered by the teledermatology clinic met physician expectations. This type of performance, facilitated through telehealth technology, will help ease physicians' and physician office staff referral workload [75].

Facilitation of second opinion and peer review are not the only ways in which HIT can improve quality and patient safety. Some physicians are infamous for their atrocious handwriting. Some physicians have handwriting that is worse than other clinicians even when asked to be as neat as possible [182]. Poor handwriting causes concern for erroneous drug dispensing [182, 360]. In some cases, it has lead to toxicity and death [360]. When pharmacists don't understand the writing, they call the physician office to get the information directly. These calls waste pharmacy, patient and physician office time [360]. The clarity of orders and a standardized, type-written method for prescriptions may reduce therapy errors. Many EMRs use electronic "forms" to ensure therapies are ordered in a type-written legible manner with consistent terminology and standardized format [361]. Even with little or no decision support capabilities, such systems can improve workflow processes by eliminating lost orders and ambiguities caused by illegible handwriting, generating related orders automatically, monitoring for duplicate orders, and reducing the time to fill orders [143]. Buyers are cautioned though: some HIT produces patient reports that are filled with significant amounts of text. Many times physicians have to hunt through paragraphs of text to get to the two or three sentences that report the diagnosis and recommendations for treatment [281]. Although EMR technologies address handwriting legibility, other issues with legibility may arise.

A barcode system integrated with a CPOE is another way to assure quality in care by reducing errors in identifying patients. A barcode on the hospital wristband is scanned prior to administering therapy so that the right patient gets the right drug and dosage [322]. The Veterans Administration has implemented the Bar Code

Medication Administration system and has seen significant reductions in medication errors [322]. Bar-coding is old and simple technology. Other, more up to date, technologies can accomplish the same thing. The technology itself is not the issue, it is the facilitation of task coordination, regardless of technology, that is relevant here.

It is clear that HIT can help to improve the quality of care. However, implementers need to be cognizant of the failure modes that compromise care delivery. There have been some examples close to home where technology has caused adverse events [148, 149]. Adverse data and medical events have resulted from insufficient inter-application design and testing [193]. In 2004, one partner organization contributing to the Alberta EHR made an application change which resulted in patient data being inserted into incorrect patient records. Root cause analysis revealed that the upgrade was unanticipated by the other partner organizations who would have needed to modify their applications to prevent the errors. In 2006, more upgrades resulted in more adverse events. In this case, a different partner organization used healthcare data in a manner for which it was not designed. The partner did not communicate how it was using the data to partner organizations and as a result several adverse medical events were narrowly avoided. Again, here in 2009, medical test results were linked to incorrect patients resulting from a software upgrade [149]. These three examples are specific examples pertaining to software systems changes made in the context of an interdependent jurisdictional EHR delivered by multiple organizations. Chapter 5 provides further background information on these breakdowns and the responsibilities accruing to administrators, physicians and technology to address them.

Adverse medical events in the Children's Hospital of Pittsburgh resulted from concurrent changes due to an HIT implementation and other process alterations [150, 275, 357]. Han illustrated that HIT implementations can lead to reductions in quality of care when too many changes, introducing socio-technical complications, are being made at one time. The Han [150], Del Beccaro [275] and Ammenwerth [357] articles thoroughly describe two independent pediatric hospital implementations of the same COTS CPOE system yielding several lessons. The Han experiment was complicated by changes in work processes which were unrelated to their CPOE implementation. Following prudent change management techniques is crucial to successful implementations. The Han experience, when compared to the Del Beccaro implementation, illustrates some of the trade-offs of a big-bang compared to an incremental implementation and shows that implementers must consciously choose the implementation timeline when striving for implementation success.

Poor socio-technical fit between the organization and the technology can yield implementation frustrations and a reduction in patient volumes. However, the dimension of patient volumes is merely a proxy for any number of dimensions on which an HIT implementation's success should be evaluated. The vertical axes of Figures 4-3 and 4-4 could just as easily be labelled as "Quality of Care" or "Patient-Provider Relationship". As an organization absorbs new information technology into its workflow, poor socio-technical fit can result in errors [362]. For those clinicians who are unfamiliar with computing technology, the graphical user interface and the mode of use can be overwhelming. The increased cognitive load can lead to information overload and confusion caused by the amount and nature of the information presented in the graphical user interface [362]. In the context of a high volume clinic driven by a fee-for-service remuneration approach and long patient wait times, overwhelm could lead to compromised decision making capacity. In these circumstances, CDS could play a role; however, some studies have shown that physicians turn off or ignore advice and warnings offered by CDS systems [363]. At the end of the day, HIT can change the way clinicians work with each other to deliver care [193]. That change takes time to settle in. The break in period can be a tenuous point during which any number of adverse outcomes, from efficiency to convenience and medical errors can occur.

Our international literature review reported that quality of care was not positively nor adversely affected by the implementation of a health information system [258, 358, 359, 364, 365]. Although we expect improvements in quality of care, in practice, there has been no consistent association between HIT use and the quality of ambulatory care [358]. There might be explanations. Not all technology is created equal. Technology is developed by engineers to reflect their perspective of how information systems should operate. Some may be more feature rich and comprehensive than others. Second, physicians may not be using decision support even if it is available within their EHR [363]. Third, institutions involved in developing and evaluating EHRs might have other attributes that allowed EHRs to be successful in changing quality, such as improved implementation and support practices which evolved away from original practice. Fourth, studies of the efficacy of HIT and EHRs may have involved intensive focus on a restricted set of outcomes that do not easily translate into real-world clinical practice with its competing priorities [358].

HIT can improve the quality and safety of healthcare, but implementers need to understand where breakdowns have occurred in the past and manage for them. Standardization on technology usage followed by staff training helps to improve coordination of integrated care [193, 253]. Adopting rigourous software operations approaches helps to coordinate the amount of technical change. One author argues that health information systems, like other interventions, should be regulated and certified [366], as will be discussed next. Should health information system users also be certified to mitigate chances for adverse events due to incorrect usage?

4.7 Conclusions

We found that health information technology can support quality in healthcare by integrating CPGs, CDSs as well as quality assurance processes such as peer review and second opinion. These benefits, however, can only be realized when care is taken to select HIT which best suits the requirements of the healthcare organization. Adopters must take care to match software features and workflow to their own processes. Socio-technical requirements gathering can be used to integrate practices' social processes with the workflow implied by new HIT otherwise adverse events and suboptimal implementation experience will result. We found that the difference between the organization's existing workflow and the workflow demanded by the system's technical features will drive change management forces, the strength of which will be proportional to the misfit between the two. Misfit places privacy, patient safety, provider-patient relations, staff anxiety, the time physicians have with patients, quality of care, financial, efficiency, and liability factors at risk. Misfit may also result in temporary (although not necessarily short-lived) reductions in patient volume. Our change management models demonstrate that reduced patient volumes can add significant cost to the overall cost of implementation in a fee-for-service pay model. Project management, physician leadership, standardization of technology and training can be used to ensure project success.

Chapter 5 –Software Operations, Procurement and Certification

In Canada Health Infoway's vision for a provincial EHR [201], point-of-service health information systems integrate through a health information exchange to create an interoperable jurisdictional EHR (Figure 2-3). In Alberta, the provincial EHR is a distributed system of interoperable applications built on a service oriented architecture. There are several disparate health organizations which have responsibility for delivering components of the jurisdictional infostructure. The former Alberta health regions have HIT delivery responsibilities within their geographical jurisdiction, but also play a role in contributing to the provincial EHR agenda.

The previous chapters have described the theoretical requirements for an interoperable jurisdictional health information system. Interoperability standards such as HL7, SNOMED, DICOM and others are well documented standards that provide for data interchange. Standards define how data will be interchanged, but applications still need to be built to exchange data in the desired manner. Jurisdictional applications need to be designed to work with each other to present a complete health information system. Point-of-service applications also need to be designed and certified to exchange information on a health information exchange. Reliable, accurate interoperability is only attained through coordinated systems engineering and operations. The standards provide the benchmark against which information exchange is designed. Software testing and certification are used to confirm that the software applications have been built properly.

In the context of a jurisdictional wide-area health information system, there is an integral relationship between physician office health information systems and the jurisdictional EHR. The EHR depends on technical and semantic integration with EMRs to properly collect point-of-service patient health information. Similarly, physician office EMR systems integrated into the jurisdictional infostructure depend on accurate health information and history for clinical decision making at the point of care. Thus, despite the focus of this dissertation being primarily that relating to the effect of health informatics on the delivery of primary care, it is necessary to evaluate the effect that jurisdictional health information systems (such as EHRs) have on jurisdictional healthcare delivery responsibilities. HIT affects the way jurisdictions work with each other to share aggregated patient information just as electronic medical records change the way clinicians work with each other to deliver care to an individual [193].

5.1 Jurisdictional software operations

The failure mode of jurisdictional health information systems can be understood by reviewing the recent adverse medical events that have occurred in Alberta [148, 149]. Such insight illustrates the responsibilities that accrue to jurisdictions when they use health informatics to deliver health services. These insights also provide lessons for physician offices as they adopt their health information systems.

In the Alberta EHR, information responsibilities are delegated to component applications in a service oriented architecture (SOA). Chappell [367] describes an SOA as a collection of applications and integration components which present as a set of integrated services. A number of individual EHR component applications are brought together to aggregately form the complete EHR. The applications' interoperability, that is, their ability to share data and participate in a complete end-to-end business process, is the essence of the EHR. As an example, a Drug Information System is designed, and only designed, to track drugs prescribed and dispensed to a patient. A Laboratory Information System only stores lab tests and results for patients. A Client Registry is used to identify patients to ensure that clinicians correctly assign health data to the correct patient. The applications are connected together by private networks and share information with each other by sending messages following the standards described earlier.

Alberta's EHR is not only built on a service oriented architecture, but the responsibility for component applications is delegated to several separate organizations (formerly RHAs). Alberta chose to implement the architectural design recommended by Canada Health Infoway [201] but realized that the Infoway model of large, complex and interdependent applications was too much for any single organization to deliver. AHW decided to partner with the RHAs and the Physician Office System Program (POSP) to take advantage of their human resource capacity and their experience implementing health information systems [193]. The RHAs had implemented integration engines, master patient indices, lab and diagnostic imaging repositories in their regional health information systems. These large independent and geographically separate organizations have many health information systems responsibilities that fall within their own regions. Their responsibilities to a provincial e-health agenda require them to be cognizant of the provincial e-health context. Thus, Alberta's integrated system requires operational coordination between organizations which do not normally work with each other.

Of course, EHR systems are, necessarily, evolutionary projects. Software application upgrades add features to the systems as business requirements evolve. Application changes must be coordinated, especially in a multi-application, multi-organizational EHR. In the publicly documented adverse medical events in Alberta, breakdowns occurred because software upgrades made by separate organizations broke the inter-application dependencies that exist between the applications [193]. Organizations did not communicate with each other prior to making changes. Absent communications prevented other applications from being upgraded to maintain the integration points in the EHR.

The adoption of information and computing technology in healthcare brings responsibilities for software maintenance [368, 369]. A method of coordinating change to ensure inter-application dependencies is particularly important in a jurisdictional EHR using a service oriented architecture delivered by multiple, independent organizations. Delivery organizations must commit to communicating planned application changes so that partner organizations can maintain integration points. It is irresponsible for interdependent organizations to focus on their own responsibilities in isolation of others. If they are to participate in a provincial EHR, a formalized method for communicating and controlling software upgrades is required. The Information Technology Infrastructure Library (ITIL was developed in the UK and has since been adopted by several organizations in several industries in several countries [370]) best practice software operations management framework coordinates software changes in large software environments. ITIL might be especially relevant in jurisdictions building an EHR through multiple interdependent organizations. Under ITIL, software upgrades are coordinated through a Change Advisory Board (CAB). The CAB consists of software operators from each member organization delivering the EHR. Their role is to evaluate the impact that any proposed change would have on the applications they are responsible for. Representatives communicate prospective changes within their home organizations and define the work needed to maintain any of their application's integration points with other systems. The representative returns to the CAB with information that will be used to determine the timeline for an integrated, packaged, coordinated release. The CAB reviews new applications and pending updates and approves their release into production. The CAB may review a prospective release several times to ensure that the design and development activities are progressing toward delivery dates. Once changes are approved for release, a release management process (Figure 5-1) governs deployment to production environments. Release management ensures there is adequate time for architecture, development, application testing and inter-application testing of several application updates which form a software release package.

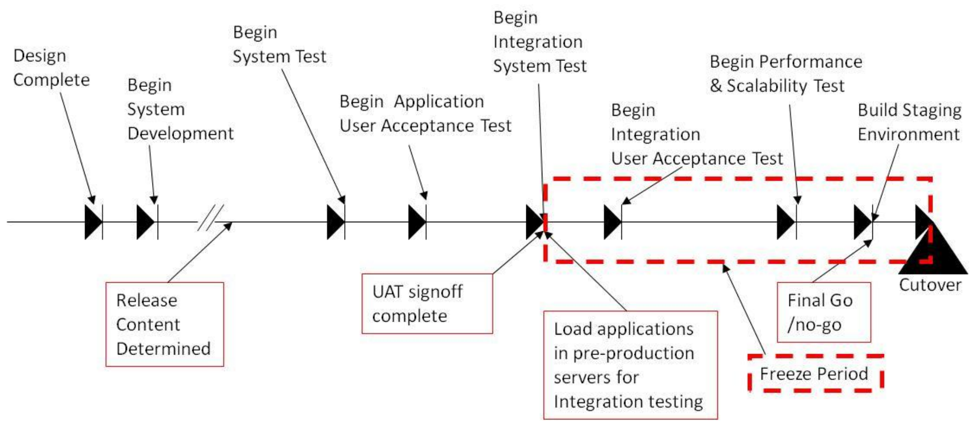

Figure 5-1 – ITIL Release Management Process

The ITIL Release Management Process has several features designed to coordinate the software operations activities and manage the implementation risk of multiple interdependent applications. The release management process provides consistent and predictable software outcomes. Several changes, possibly in several different applications planned for delivery in the same time period, are combined into release packages. Prior to starting software development work, the business owners of the applications determine how they wish to update their software. The business planning documents are used to build engineering design documents from which the software updates will be coded. At this point, wise project managers approach the CAB to inform them of pending changes so that partner organizations are aware. This gives them the time to assess how proposed changes may affect integration. Once the design is complete, system development can begin. This period might be quite lengthy as software engineers develop the code for new software or application upgrades. During this period, the CAB determines exactly what the release content will be for future release packages. Once the software developers have substantially completed their development tasks, they submit it to quality assurance testers to test the system. System testing focuses solely on the application's functionality and does not concern itself with how the application integrates with other EHR systems. User acceptance testing (UAT) works through issues as experienced from the users' perspectives. UAT and system testing are iterative processes through which testers and developers bring the application up to the functionality intended in the business plan. If the applications pass these two series of tests, then the applications can be considered for release according to their schedule. No further features can be added once the schedule has entered into a freeze period. A freeze period offers developers and testers an opportunity to focus on the current release without being distracted by additional requirements that might be coming from external project stakeholders or business managers. The freeze period locks out last minute changes to minimize the risk that one of these changes breaks interoperability. Once the application functions as expected, then integration testing can be initiated. Integration testing tests the integration points of interdependent applications to ensure the applications interoperate as expected. During this freeze period, applications can continue to be refined, but eventually must be ready for integrated performance and scalability testing. Scalability and performance testing ensure that the applications can withstand the load that they will experience in the production environment. A standard approach to release management allows all partner delivery organizations to stay abreast of the progress of others so that a release can be coordinated into release management packages.

Release packages can be prepared depending on the size, urgency and nature of the individual changes. Release packages are categorized into major and minor releases as well as high priority releases. Major and minor releases differ by the degree of technical complexity of the software updates. The greater the implications of a change, that is the greater the technical risk the changes represent, the more likely the package should be categorized as a major release. Major release packages are only deployed a few times per software cycle because of the amount of integration testing required to confirm that interoperability won't be broken [368]. Minor releases contain changes that are not intended to change integration. High priority releases are only used to make immediate changes to applications without which patient safety or privacy would be compromised. High priority changes may be implemented at any time, subject to approval by the CAB [368]. High priority releases bring their own risks because the urgency of the software upgrade sometimes limits the amount of integration testing that can be completed. Thus the temptation to defeat the release schedule by labelling a release as a high priority release should be avoided. Inevitably though, in the highly political circumstance of an EHR, there are pressures to use high priority releases as a vehicle to implement non-urgent changes to meet self-imposed deadlines. To minimize implementation risk, new releases can be implemented on off-line, mirrored servers first. This permits integration testing to occur in a production-like environment first. If testing is successful, the new versions can be swapped into production by switching off production servers and turning on the mirrored servers, making the cut-over to the new release much faster.

Although ITIL brings greater awareness of inter-application dependencies, better quality assurance and the confidence that clinical incidents can be avoided, it also brings more process, more paper-work and less business freedom to make ad-hoc updates [193]. Adopting the ITIL model is not easy because it requires changes to entrenched organizational software operations processes. It restricts organizations' software delivery processes. Organizations are not permitted to implement software upgrades according to their own schedules, but needed to coordinate their releases through the CAB. It can take a long time to integrate the framework into organizations' workflows [193].

5.2 Physician Office System Procurement and Software Operations

The above Change and Release Management processes can go a long way toward minimizing the risk of adverse events resulting from insufficient software operations management in the jurisdictional infostructure. What about point-of-service applications? How do we manage the risks inherent in software operations in the physician office? How do we manage the operations of systems installed in independent, private, for-profit physician offices which are delivered by many, independent, private, for-profit software companies? Converting a healthcare practice to a new EMR, whether coming from paper or another electronic system, is a daunting task. There are many unknowns. There are many risks. Project risk management is a method of systematically managing uncertainty to increase the likelihood that the project will achieve its goals [371]. Chapter 4 outlined several relevant risks. Risks need to be managed so that adverse events do not derail the project, which may result in project delays or increased project costs.

Physicians face procurement risk, if they are not able to select a high quality product that supports a minimum level of healthcare delivery. This risk is compounded when physicians do not take the time to properly select a physician office system that best fits their specific practice requirements [161] (they select a product for which their practice lies in the "marginal fit" or in the "no fitness for use" part of the curve shown in Figure 4-1). Our international literature review and other studies have reported the liability risk physicians face by using software that does not support their specific workflow [227, 230, 253]. Liability is also compounded if physician offices select a low quality product that has poorly functioning features or does not offer the features needed to deliver the appropriate levels of care. Of course, physicians face significant financial risk in purchasing physician office systems. EMRs are extremely expensive propositions. Physicians complain that most benefits accrue to payers and patients when most of the costs are borne by physicians [284, 372]. As described above, there physicians face operational risks due to their responsibilities for maintaining computers, software and networks.

Just like many other engineering projects, evaluating, selecting, procuring, implementing and operating any HIT is a project. The literature reports that implementation failure can be minimized by using project management processes [272, 273, 275, 293, 295, 306, 310, 311, 312] because they control the scope, procurement, schedule, tasks, resources, and quality of the project. All projects are one-time, unique and temporary endeavours designed to produce an outcome [371].

Whether implementing an EMR for a solo physician office, or a large, inter-organizational, interoperable, jurisdictional EHR, project management processes can be used to manage resources, the schedule and the budget. Project management processes manage the implementation, procurement and risks that come with change.

In the case of physician office systems implementation, few physicians have the knowledge, skills, experience or the confidence needed to run a project [78, 161]. Physicians are advised to learn about the HIT market, the vendors playing in it and the strengths and weaknesses of their products. This starts with an introspective review of the physician office's needs. Physician leaders must consider how they work, how they use their staff, and their preferred methods of documenting patient health information. They need to define the role that the HIT will play in their office. This is called requirements gathering, a process through which physicians determine their needs and the objectives that the system will need to address. The previous chapter discussed the benefits of socio-technical requirements gathering and the additional enlightenment it offers physicians in their information gathering efforts. The requirements gathering process helps physicians to establish criteria that can be used to evaluate vendor products.

The next step in the project is to gather information from vendors about their products' features. As discussed in the earlier chapter, not all health information products are built the same. Each is the product of the design philosophy and user feedback of their vendors. Different products aim to address different problems in the physician office and so physicians need to consider the strengths and drawbacks of various products with respect to their practices. There are many avenues available to physicians for gathering product and vendor information. Physicians can talk to sales representatives, they can attend demonstrations, and they can visit vendor booths at tradeshows. Physicians can conduct their own market scans, price analyses and refer to industry publications to become familiar with the different products and features. Interestingly, our recent studies showed that physicians in smaller suburban physician offices tend to skimp on their efforts in information gathering [161]. Only one followed a procurement plan consisting of a market scan, price analysis, vendor demonstrations, and visiting colleagues' clinics. Only two physicians completed a price comparison, while one called their professional association for procurement advice, another acquired his EMR through personal connections, and yet another could not remember how he had selected his EMR [161]. Conversely, primary care physicians operating in urban, academic or hospital settings took a more proactive approach to procurement. They spent more time networking with colleagues to understand the vendor market [78]. They even devoted funds to a non-clinical project management resource to implement the project and work through any post implementation technical support requirements [78]. Physicians took time to train themselves and their staff on their system. A project resource, who is familiar with the project management process, can carry out project management tasks on behalf of physicians, leaving them to see patients. Many project resources are not physicians or even clinical staff. Often they are administrators who bring the project team together, to organize and execute the project plan. They lead the various meetings and other activities, which are extremely time-consuming, and require specific project management skills that are not commonly present among practicing physicians [265]. Once the physician office system has been implemented, some practices have converted the project manager's role to that of a technical vendor liaison – the "go to" person for any usability concerns or training concerns for physicians [63, 78]. We found that larger physician offices could generate the revenue to support a non-physician project manager/vendor liaison resource, whereas none of our suburban physician offices had such resources in place [78, 161].

There are other strategies that are also available to help minimize the project risk. Where feasible, EMR implementers might wish to limit the amount of change taken on at once, so that clinicians have a chance to adjust to the change [296, 325] before an adverse event results from misunderstandings created among many other system or process changes [361]. Ideally, new physician office system updates or patches are tested, in the office, before implemented. Easily said, but often not possible due to the time constraints physicians operate under. Coordinated workflow can be achieved by training staff to use the EMR in a consistent manner. The training creates a common understanding on how the physician office system will be used in the practice [167]. The intensity of training, the timing of the training and the availability of training and post-implementation support all help to shorten the restabilization period [303, 307, 310, 314, 315]. Access to experts on call (or "at the elbow" [246]) and post-implementation training improve clinicians' early experiences with the system when restabilization starts [78, 171]. By extension, standardization of clinical terminology, lab test results ranges, the way the EMR is used, as well as the type of information saved in an EMR can help realize the benefits of an EMR across an interdisciplinary team of care givers in a physician office [168, 253, 292, 315, 316]. Standardization and training ensures all system users know how to use a system in a consistent manner, permitting them to anticipate what others in the organization are doing with the system. In summary, stronger physician professional networks used in information gathering, more complete training, a managed approach to implementation and in-house technical support seemed more influential than remuneration in facilitating the adoption experience.

5.3 Health Information Systems Certification and Conformance

5.3.1 Introduction

Jurisdictions running the jurisdictional infostructure and physicians running physician office systems need to manage procurement and software operations risks to avoid adverse events brought forward by the HIT itself. The previous two sections illustrated the risks that jurisdictions and physician offices face. Jurisdictions face software operations management risk when they make updates to their software. Change and Release Management processes are used to manage the risk to ensure interoperability is preserved. Physicians face procurement, liability, financial and operations risks of their own when they decide to pursue electronic records management. Product evaluation, selection, implementation and operation are complex work which distracts physicians from caring for patients. Left to their own devices, physicians would not adopt HIT [184, 285, 356]. Physicians need help. The business case for HIT adoption is not obvious in a fee-for-service remuneration model [373]. Physicians argue that since payers receive most of the benefits, payers should also bear some of the costs [105, 184, 324, 356, 372, 373, 374, 375].

The complete EHR depends on the jurisdictional infostructure as well as point-of-service systems such as physician office systems. There needs to be some way of integrating jurisdictional software operations management with physician office system risk management to ensure all systems exchange information properly across the health information exchange. Jurisdictions have implemented conformance and certification programs which strive to mitigate the risks described above for both the infostructure and physician office systems. Certification and conformance programs are designed to mitigate the procurement, liability, financial and operational risks that exist in an e-health environment while delivering the integrated EHR [167, 215, 258].

5.3.2 How does certification work?

In a previous literature review [215], we found a number of organizations which facilitate the adoption of HIT in primary care. Certification organizations were found in Alberta, British Columbia, Saskatchewan, Manitoba, Ontario, the United Kingdom, the United States, Denmark, Australia and New Zealand (Table 5-1). The certification organizations in these jurisdictions have varying organizational structures, certification objectives and strategies for facilitating the adoption of HIT. However, some commonalities exist. They facilitate physician office systems adoption in two ways (Figure 5-2). They regulate physician office systems markets by pre-testing vendor products against standards (Jurisdictional Certification Process). Second, they provide procurement support to physicians (Physician Procurement Process).

Table 5-1: Certification organizations in countries with High HIT adoption

Jurisdiction		Alberta	British Columbia	Saskatchewan	Manitoba	Ontario	United States	England	Scotland	Australia	New Zealand	Denmark	Sweden
Certification Organization		POSP	PITO	SMA	Manitoba eHealth	OntarioMD	CCHIT	GPSoC/ CAP-GP	SEF	NEHTA	Connected Health	MedCom	N/A
Conformance Objectives	Interoperability	√	√	√	√			√		√	√	√	
	Connectivity									√	√		
	Workflow	√		√									
	Functionality		√		√	√	√	√	√			√	
	Performance					√							
	Usability							√					
	Privacy		√		√		√						
Market Type		Closed	Closed	Open	Open	Open	Open	Open	Closed	Not decided	Open	Open	N/A
Fee payment required		No	No	No	No	Yes	Yes	No	No	Not decided	No	No	N/A
Duration of Certification		Mar 31, 2011	Mar 31, 2012	Not decided	N/A	2 yrs	2 yrs	2 yrs	Life	Not decided	3 yrs	Life	N/A

Figure 5-2 illustrates the two intersecting and concomitant responsibilities of certification organizations. The Jurisdictional Certification Process is responsible for certifying a number of HIT systems for purchase in the jurisdiction. This process is responsible for ensuring that the health information systems available to physician offices meet objectives set out by the jurisdiction. Different jurisdictions have different objectives as shown by Table 5-1. Some organizations want to improve functionality, usability, system performance or workflow. Others wish to ensure that systems are interoperable and will support connectivity with their central shared health record. Yet others are concerned about the privacy and security of patient data, and will only support those systems which meet their strict standards for handling data. The certification program establishes goals that the jurisdiction wishes to achieve through their e-health agenda and then ensures those goals are met.

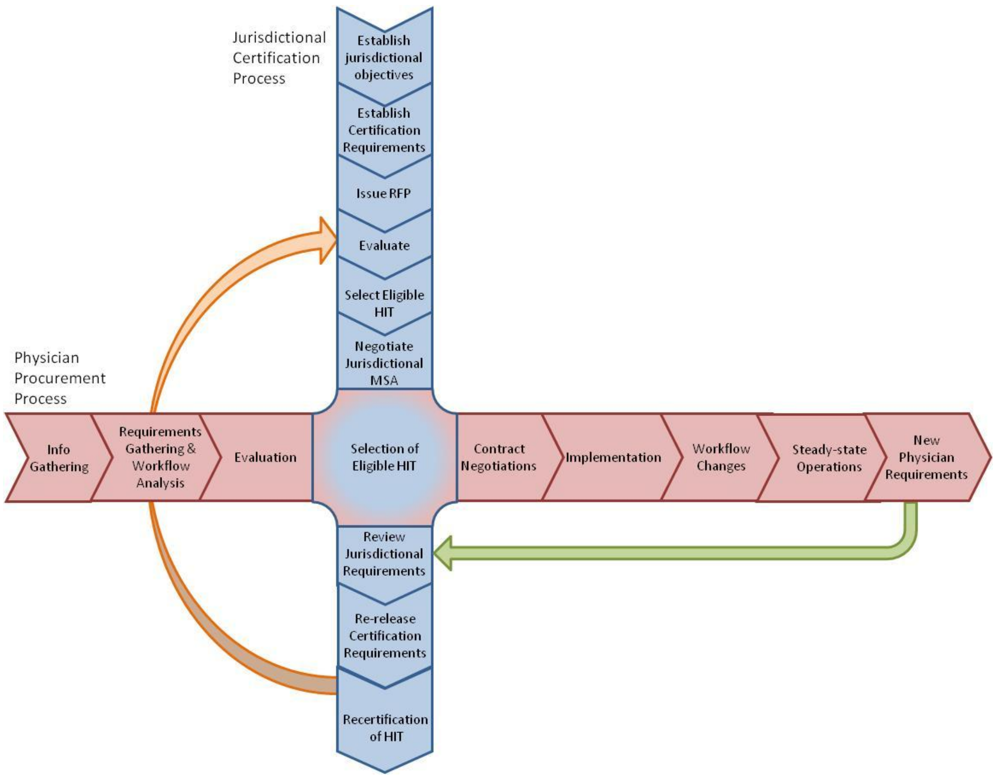

Figure 5-2 - Certification and Physician Office Product Selection Processes

With objectives established, the jurisdiction carries out a partial procurement process. Many certification organizations provide system requirements to vendors, often through a Request For Proposal (RFP) approach, evaluate systems and then designate approved systems as eligible for purchase [215]. Many of the jurisdictions will require Master Services Agreements (MSAs) with vendors to ensure vendors adhere to measures for performance. Measures for performance may be network quality of service targets, technical support response targets, a commitment to follow a jurisdictional software operations framework, or adherence to established price levels.

At this point, certified systems are available for purchase and implementation. Physicians wishing to purchase a system would follow the Physician Procurement Process to select an eligible system. Physicians start by gathering information about systems as described previously. Some certification organizations provide transition coordinators who lead physicians through a requirements gathering process to help them understand their specific clinical workflow and HIT system needs [376, 377, 378]. The certification organizations will help physicians determine the criteria on which they may make a selection and the weighting given to each criterion. At this point, the two processes intersect as the physician selects a system from the list of pre-qualified systems. The physician office will enter into its own negotiations to contract for provision of the system. The vendor-physician contract will be governed in the context of the MSA between the vendor and the certification organization. The vendor and the physician will implement the new HIT system which will imply the workflow changes described in Chapter 4. Once the physician office has re-established steady state workflows, physicians may be in a position to offer suggestions for product improvement. These suggestions are funnelled into the Jurisdictional Certification Process when new versions of the Certification Requirements initiate the recertification cycle. Our literature review found that many certification organizations had time limited certifications [215]. Time limited certifications required vendors to recertify on a periodic basis, thus ensuring that there was always incentive for vendors to provide high quality and context relevant products.

5.3.2 How does certification affect the adoption of HIT?

Certification organizations are instrumental in facilitating HIT adoption on both the infostructural and point-of-service sides of the health information exchange. Certification programs establish certification requirements which are used to test all components of the EHR. As illustrated in Table 5-1, some jurisdictions have set up their certification programs to facilitate interoperability and connectivity with infostructural systems. Certification organizations centralize a number of responsibilities, thereby lifting them from physicians' shoulders and, arguably, placing them into the hands of more qualified resources [63]. For example, certification organizations test HIT systems by hiring qualified professional testers. Certification organizations are more qualified testing agencies [379] than physicians themselves. Certification organizations have the time and the expertise to conduct thorough testing to ensure products will meet the objectives of the jurisdiction. Physicians are assured that certified products are high quality. Thus, certification organizations facilitate adoption because they mitigate liability risk due to poorly designed software [215]. They report functional deficiencies to vendors and buyers. Malfunctioning products may be ejected from the market if vendors are unable to improve them, reducing practice liability due to low quality systems design. Transient or uncommitted vendors are ejected from the market because they can't meet the design requirements tested by the certification organizations [105, 304].

In some jurisdictions, certification organizations not only pre-test and certify systems, but they provide some financial incentives to physicians who choose to buy certified systems. Financial incentives might come in several forms. In Alberta and BC, POSP and BC's Physician Information Technology Office (PITO) pay for 70% of the cost of physician office systems. Both Manitoba and Saskatchewan have arranged the fee structure to incent physicians to report usage of their EMR systems [134, 380]. Physicians using their system to manage health information electronically and achieving higher quality of care receive higher fee-for-service rates [380]. In the US, Certification Commission for Health Information Technology (CCHIT) does not offer direct financial reimbursement for HIT purchases, but insurers have reduced malpractice insurance premiums for those physicians using CCHIT certified EMRs [381]. A US Congressional stimulus package will offer $40,000 in Medicare incentives to physicians who use electronic systems [217]. Some organizations provide reimbursement for capital costs [215]. Even when physician funding is not part of programming, often other economic benefits accrue to physicians such as more competitive pricing [382, 383] and liability insurance discounts [384].

Certification organizations also facilitate adoption by supporting physicians through the procurement process. The Jurisdictional Certification Process centralizes much of the procurement process for physicians. Certification organizations provide plenty of advice for those portions still left to physicians. They facilitate workflow analysis, facilitate requirements gathering, coach physicians through contract negotiations, advocate for physician office training and ensure that technical support is provided to physicians in a timely manner [376, 377, 378].

Certification organizations also alleviate some of the operational risk to physicians. Software vendors frequently update their products with patches and updates to address malfunction and improve features. The Jurisdictional Certification Process controls these software releases by integrating recertification into the process [215]. Vendors are still allowed to update their products as required, but major functional changes are controlled through the recertification process. Thus, physicians do not have to worry about frequent software changes that require adjustment to their workflow and retraining their staff.

5.3.3 Implications of Certification

Certification organizations offer interesting effects in the general market. Some jurisdictions maintain open EMR markets and some of them close markets after certification is complete (Table 5-1). A closed market is one where, once a list of certified products is available, no other vendors' products can be sold in that market. Even if markets remain open, practically speaking, any vendor product which has been certified has a significant marketing advantage over those not certified [215]. CCHIT offers a seal of approval, which can be used as a market differentiator by vendors [385]. Manitoba intends to promote certified systems to physicians and limit RHAs' purchases to those vendors on the approved list [134]. Even in jurisdictions with closed market policies, many vendors post their success on websites or promote their success in advertisements to remain competitive. In either case, jurisdictions affect the free and open enterprise mechanisms that drive competition in the market. Many countries' economic engines are based on the free and open competition that causes products and services to become better. Thus, certification organizations must control applications to ensure their objectives are met but should not compromise the economic, competitive mechanisms that drive quality. An optimal range of approximately 3 to 6 certified systems is recommended to balance competition with the administrative costs of certification. Insufficient GP choice and vendor competition result when too few vendors are selected (as the Scottish experience implies) [215]. Programs with two approved systems will offer some choice to physicians and control jurisdictional certification expenses; although jurisdictions do better to have three approved systems in case one vendor fails [134]. Jurisdictions with too many certified systems may leave too many choices for physicians, which compromise the objectives of certification in the first place. Jurisdictions with open markets can expect to have higher testing and administrative costs as they certify a large quantity of systems and subsequent versions. It is interesting that the US and Ontario, two large jurisdictions with open markets, appear to offset certification costs by charging vendors.

Another implication of certification pertains to those physicians who already have EMR systems, but which are not certified or which lose certification. In closed markets, physicians who were using products which subsequently failed certification must migrate to a different solution if they are to maintain access to funding. Of course, physicians are independent offices. It is their prerogative to stay with their existing system given all of the complications discussed previously in this dissertation. Still, certification organizations need to guard against causing too much change for physicians by certifying products in a first cycle, but then delisting that same product in the next. Such circumstances would offer strong incentive for physicians to stay on their current software given the implications for change described in Chapter4.

Clearly, certification has significant consequences for the private sector software companies producing physician office systems. Naturally, taxpaying HIT software companies have already complained about how failure in certification has compromised their ability to be competitive in the market [386, 387]. Jurisdictions must consider the cost and competition implications when certifying systems and setting policies.

Another competition implication arises when certification organizations offer financial incentives for physicians. The issue is particularly well illustrated in the US where anti-kickback laws prevented hospitals from financially supporting physicians with systems purchases that would integrate with hospital CPOE systems [362, 388, 389]. There is no doubt that well integrated systems between physician offices and hospitals would help improve continuity of care when general practitioners admitted patients to hospitals. But, hospitals could not (previously) be seen to be financially biasing physician offices towards a select number of EMRs that integrated with their CPOE systems. Since that time, the US Department of Health and Human Services and the Internal Revenue Service have clarified that hospitals may support physicians in their purchases [388], but the issue is still relevant.

How can jurisdictions provide financial support to purchase business systems when they offer no other financial support to any other industry? The Canada Revenue Agency does not offer financial incentives to accountants to purchase accounting systems that integrate with the central tax processing system. Instead, natural competition has ensured that electronic tax filing features are available in almost all personal and corporate tax software. Lawyers are not paid by the legal system to buy and use software that facilitates the easy submission of documents to the courts. Why then, in Canada, are physicians being paid to buy, what amounts to be, their everyday, simple business software? Clearly more study is required to understand the relationship between physician reimbursement and HIT adoption. More study is required to compare these industry circumstances and to offer insight into this concern.

Certification organizations consolidate feature, functional and interoperable requirements gathering which articulates a purchasing power that small physician offices would not have. Physicians do not have the technical and software product management backgrounds to demand changes in software products [253]. However, a physician led certification organization offers significant market influence. Such organizations advocate for and leverage the market power of large volumes of physicians. A cohesive approach can benefit vendors too. Software vendors benefit from a common set of interoperability requirements, minimizing multiple, sometimes conflicting, requirements from physicians. Canada Health Infoway is considering a national conformance program [390] while POSP, PITO, Saskatchewan, Manitoba eHealth, and OntarioMD collaborate to help minimize development effort to vendors in Canada.

5.4 Remuneration, reimbursement and adoption

Remuneration is a complex and highly debated healthcare topic. The historical FFS model, and the behaviours it drives, is an appropriate remuneration tool in this era of mismatched healthcare supply and demand. However, as patient populations age, and the demand for chronic care rises, the FFS model incents physicians to under-provide care to individuals needing advanced care in favour of meeting the demand of the rest of the population. As patients age, their desire for a deeper friendship with their physician conflicts with their physicians' motivations under the FFS model. At the same time, physicians' independence and the unlimited revenue potential offered under FFS has caused some to work themselves to a point that is untenable moving forward.

In the early stages of these studies, the author was convinced that there was a direct and undeniable relationship between physicians' interest in evaluating, selecting, implementing and adopting HIT and their remuneration method. Those physicians with a long term view would see HIT as a means to attain operational efficiencies which give them access to more revenue potential after implementation. The office efficiencies obtained with the support of HIT would allow physician offices to attain higher long term post-transition steady state patient volumes. Those visionary physicians could justify time away from seeing patients (and the associated short term reduction in FFS revenues as illustrated previously) because their investment would pay off with better long term cash flow ($\triangle PV_{Post} > 0$). We wished to learn more about how HIT affects remuneration and remuneration systems and how these systems in turn affected HIT adoption.

Our international literature review [253] reported that adoption is influenced by financial factors, but to varying degrees in different jurisdictions. This would seem to be supported by Table 2-1 which illustrates varying levels of HIT adoption in jurisdictions with varying remuneration models. “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” [253]. In fact, as we have said before, left to their own devices, physicians would not adopt HIT [184, 285, 356]. From physicians’ perspectives, the business case for adoption doesn’t make sense [373]. Given the trials discussed in Chapter 4, maybe they are right. 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 [284, 356]. Our international literature review concluded that a more detailed investigation of financial reimbursement models for adoption and their implications to physician remuneration models was required.

Two further studies [78, 161], both remaining in the Alberta context, were undertaken to understand more about the drivers of EMR adoption. First, we studied the adoption experience of suburban physicians to understand the drivers and barriers to adoption in a community care based circumstance. Then, in the second part of this two part series, we conducted interviews with urban, hospital and academic based family physicians to understand how remuneration and care setting affected their evaluation, selection, implementation and adoption of EMRs. Both studies were conducted in Alberta because we wanted to control for the type of reimbursement model that was in place. The first study, with suburban physicians, examined the adoption experience of community based GPs who are members of a PCN (which of course brings its own biases). Lead physicians or influencers who had recent EMR implementation experience were interviewed with an interview guide which was developed from the findings of our international literature review and tested prior to the study. These semi-structured interviews found that physicians chose not to invest the time in systems procurement because they were uncomfortable with the process. Investigating systems during office hours reduced revenue generating opportunity under the FFS model and increased patient wait times [161]. When combined with our physicians' general lack of familiarity with HIT and the HIT market, they felt there would be too much time required to undertake anything more than haphazard unplanned investigations. Physicians did undertake investigations, but did not follow a robust, complete procurement process [161]. In conclusion, we wondered whether the current fee-for-service payment model creates an urgency to maintain patient throughput. We suggested that the opportunity to maximize clinic revenue with waiting rooms full of patients discourages physicians from investing the time in EMR implementation activities [161].

In an effort to shed more light, the second study searched out physicians who were practicing in a different remuneration model or in a different care setting to understand their implementation experience. Lead physicians practicing in urban, academic or hospital settings were interviewed using a similar interview guide to the one used above. Some of these physicians were paid on an ARP basis while others had access to sessional pay for the purposes of procuring a physician office system. Thus there was a small opportunity to compare their physician office system adoption experience with our suburban study. The study found several differences between suburban physicians paid on a FFS basis and their urban/hospital based or academic colleagues paid through non-FFS methods. Urban physicians tended to follow a more complete investigation approach, informed more by their colleagues' opinions and past experiences compared to suburban physicians who did not quote colleagues as an information source. In fact, urban physicians tended to view their fellow physicians as colleagues as opposed to our suburban interviewees who saw their fellow physicians as competition in the healthcare market place. Urban practices tended to be bigger in size and often hired a project management resource to oversee the implementation. This resource then transitioned to a vendor liaison and training resource after the system had been installed. We found that physicians in the suburban setting tended to follow "big-bang" implementation approaches whereas the larger urban clinics took the time to implement in a more incremental, phased approach.

Our hypothesis was such that physicians paid on a non-FFS basis would have more time to investigate, select and then implement their physician office system. These two studies did not, however, suggest that alternative payment models facilitated adoption any more than FFS. While the second study found physicians took more time in implementation, both studies found physicians complaining bitterly about the lack of time to conduct the first 3 steps of the Physician Procurement Process (Figure 5-2). Again, if any conclusion could be drawn from these two studies, it would be that the size of the urban clinics offered more resources to acquire supporting services (project management resources, more extensive training and a planned, incremental and controlled system rollout). Other activities still occupied physicians' time, preventing them from undertaking a complete procurement approach regardless of how they were paid.

Our two part study series examining the effects of remuneration on adoption proved inconclusive. Subsequent to these two studies, we recalled from our international literature review that certification organizations claimed to mitigate physician liability, procurement and financial risk. As a follow up to our international literature review, a review of GP systems certification programs was conducted to understand how the reimbursement components in these programs combined with physician remuneration policy to support adoption [215]. The analysis found that reimbursement programs tended to be targeted at fee-for-service GPs [391, 392, 393, 394, 395]. Programs used a number of different mechanisms to facilitate adoption. Some offered lump sum reimbursement for capital costs [396, 397], while others added top-ups to FFS billings if the GP system was used to report patient outcomes [134, 380] or achieve quality targets [127, 134]. Many programs supported physician adoption in indirect ways by offering peer support [380, 397], transition support [398, 399], and procurement support [399]. Although these are non-financial aspects of the programs, they resulted in time savings for physicians, which equate to lost opportunity cost savings in a FFS model. Clearly, there is a relationship between remuneration, reimbursement and adoption as inferred by the reimbursement programs' orientation to FFS physicians.

This thesis has spoken extensively about time physicians have to investigate, evaluate, procure, implement and adopt a GP system. As mentioned previously, physicians' time is their most valuable commodity [105]. If physicians in both FFS and blended pay models cannot find the time to investigate these systems, then what is taking up their time? Well, the answer to that question is widely varying. Physicians have many draws on their time. As outlined in the background section, the new generation of medicine suggests that more physicians will spend time with their families in the future. Primary care reform demands that physicians use some of their time to lead interdisciplinary teams. Chapter 7 outlines many other distractions brought on by HIT itself. As a physician office practice gets older, so too do its patients. The complications of aging drive longer patient appointments [71]. Those patients have gotten to know the physician more, and so there is a greater interest in socialization, on both the part of the physician and patient [172]. Physicians develop specialty interest to grow their career, which takes away from their practice time [172]. These are just some of the factors that HIT adoption must compete with for physician time.

Remuneration models are one of many factors contributing to adoption. Again, this conclusion would seem to be echoed by Table 2-1 which shows a number of countries with both high and low adoption rates for physician office systems. The table illustrates that there are a number of remuneration models in place such that there is no specific remuneration model that can be credited with greater adoption success over another. For example, Australia pays its GPs exclusively through a FFS model and enjoys very high adoption. Canada pays almost exclusively through FFS but has low adoption. The US has low adoption with a completely different healthcare financing, insurance and remuneration model. Denmark pays 70% through FFS whereas Sweden's physicians are mostly paid via salary. Both have very high physician office system adoption rates. Frustratingly, there seems to be no one reason to indicate why high GP systems adoption countries have had such success in adoption. More relevant to this chapter, our studies cannot suggest that one remuneration approach supports adoption over another [400, 401].

Remuneration, combined with physician office reimbursement plans, may create an opportunity to stimulate the building blocks of adoption in primary care. It is difficult to separate the implications of the remuneration model from the implications of the reimbursement models described above. The reimbursement models described in earlier parts of this chapter tend to focus on supporting HIT adoption of physicians paid on a FFS basis [215]. However, they do so in many ways as has already been discussed [215]. These various approaches frustrate the analyst trying to determine the factors and influencers that drive health information systems adoption in primary care.

The agencies which administer GP systems reimbursement models tend to be the same as, or associated with, centralized organizations charged with a mandate to drive adoption. Although not exclusively, these centralized certification organizations also tend to exist within centralized health systems, causing us to believe that the degree to which a jurisdiction has centralized its healthcare policy and delivery contributes to adoption [400, 401]. Considering the low adoption in both the US and Canada, the relatively decentralized nature of these two countries' health systems may be to blame for their low adoption. There are advantages that centralization offers which may be conducive to adoption. At the jurisdictional level, centralized systems offer standardization in messaging, software development, software operations, lab test results decision levels and patient safety standards [400, 402]. At the clinic level, centralization justifies the acquisition of computers, internet service, secure transmission channels [227]. In decentralized healthcare systems (and also in decentralized healthcare informatics systems) often, there is a lack of trust among stakeholders to share data in a reliable and safe manner. Decentralization might tend to result in uncoordinated efforts, duplication and misaligned organizational purposes [193, 402]. Even remuneration policy may differ across the provinces [227]. Could primary care reform stimulate centralization of information exchanges at least within their member clinics [403]? Will the recent centralization tendencies in Alberta serve to support EHR and EMR adoption?

5.5 Conclusions

Our review found that centralized software operations and certification offer many benefits to the adoption of HIT at both the jurisdictional and primary care levels. When jurisdictional EHR systems are delivered using an SOA architecture by multiple interdependent organizations, data, software development and software operations management standards are needed to coordinate otherwise disparate EHR delivery activities. ITIL release management, controlled from a centralized CAB, can help to control software development and operations activities but adopters should be prepared to trade improved control and safety for business flexibility and freedom.

We found that certification organizations can facilitate physician office system adoption by mitigating liability, procurement and financial risk to family physicians who buy pre-qualified EMR solutions. They support HIT adoption by standardizing requirements gathering, feature testing, procurement and adoption while providing reimbursement to qualifying family physicians. We suggest that certification organizations limit the number of approved systems to a range of 3 to 6 systems. This will ensure physician office system vendors have market competitive forces needed to drive product improvements. It also ensures physicians have enough choice to select an optimal system for their practices. We also suggest that certification organizations connect physician reimbursement for adopting pre-qualified systems to usage or quality of care.

Chapter 6 – Advanced Access and Office Efficiency

6.1 Advanced Access

Advanced access, also known as enhanced access, open access, same-day scheduling or lean thinking, is a physician office strategy for increasing capacity to deliver care [28, 175, 176]. Advanced access has several strategic components designed to be able to offer patients appointments on the day they ask for one. Advanced access seeks to ensure that office tasks are appropriately matched to the right member of the physician office. When supply is matched to demand and tasks are properly assigned within the team, advanced access suggests that the waitlist will stabilize (queuing theory says that the waitlist will stop growing when patient arrival rate is equal to or less than the service rate). A stable waitlist (a stable queue) means the physician office is meeting demand, but may still need to work down its backlog to offer timely care [404]. Short and even stabilized waitlists encourage patients to seek care from their own physician. Physicians are strongly encouraged to see their own patients and discourage patients from seeing other physicians (such as emergency rooms or walk-in clinics) [117, 118]. When patients see their own physician, the encounters are shorter, because there is less time taken up in developing rapport, establishing credibility, taking initial history, and understanding the patient's health circumstances [28]. When seen by their physician, patients are more comfortable asking health questions, accepting their physician's recommendations and physicians were able to design care plans for their patients [177]. When patients are unattached to a physician, or can't access their own physician, they use other healthcare services to address their problems [15]. As Murray says "see your own, and don't make 'em wait" [405].

A key feature of the advanced access model is the scheduling approach, which differs dramatically from the tradition model used in most physician offices. Under the traditional model, physician offices book appointment schedules to capacity. They stipulate that patients are permitted to bring forward only one, or possibly two, problems. Other problems must be addressed in another future appointment. When the schedule is full, a patient calling with an urgent problem must go to emergency (since there is no room in the schedule), be double booked into his/her physicians' schedule or be booked at the end of the day. These options push current work into the future, exacerbating demand that has not been addressed.

The advanced access model approaches scheduling from the opposite perspective. Instead of pushing demand (driven by multiple problems or emergent problems) into the future, advanced access books today's patients today [175]. Patients who see their physician are encouraged to address any and all problems in the current appointment (called "max packing" appointments) so that any future consultations are addressed in the current one. Future capacity is freed up so that future patients can be booked on the day they call in.

Physicians practicing in the traditional model can adopt the advanced access model, but they must first address their backlog (their waitlist). Physicians can work down their backlog, addressing future demand by temporarily increasing capacity to meet current demand and work into future demand. They do this by adding additional hours, looking to see if patients have future appointments which can be satisfied in a current one, and reducing the frequency with which they bring patients back for follow up appointments (which reduces internally generated demand) [175, 176, 179]. Offices are encouraged to develop contingency plans for peak demand (such as Monday mornings, back to school periods, flu season, vacations, etc) so that temporary surges in demand do not cause waitlists to develop [175, 176]. Advanced access is not sustainable if there is a permanent mismatch between supply and demand [175] or if variation in either demand or supply is too great. If demand permanently exceeds supply, physicians can recruit partners into a multi-physician practice to share the load. They can also decrease demand by decreasing the number of visits per patient per year, lowering the internal demand for follow up appointments (if appropriate) [406], providing more service at each visit to minimize the need for future visits [407] and using alternatives such as email, telephone or group visits [408].

There is efficiency in a purposeful exam room design. As with other forms of standardization [253], standardized exam room layouts have efficiency benefits. Physicians should sit face-to-face with patients when recording data in an EMR to maximize the quantity of patient-physician interaction [161]. Exam rooms may require reconstruction so that eye contact can be maintained while entering data into the EMR. Exam rooms can also be rearranged such that equipment, tables, sinks and chairs are positioned in the same location in each room so that physicians do not get disoriented and don't need to search for equipment during an encounter. Exam rooms should be stocked with supplies before the start of the business day so that physicians don't interrupt an encounter to chase supplies. Exam room design is important in facilitating the patient-provider relationship, which further enhances the trust that helps to make office visits more effective [28, 121, 177, 178].

Like many small business owners, physicians take on many tasks (not necessarily all physician tasks) to manage their risk as small business owners (75% of physicians feel they do things they should not be doing [69, 409]). There are many types of non-physician tasks. There are non-physician clinical tasks such as taking vital signs, reviewing medications, reviewing lab test results and DITRs. Physicians do not personally need to take family history or allergies, yet many physicians do this all the time. There are also administrative tasks that physicians sometimes do. Tasks such as rooming patients, scheduling appointments, completing special authorization forms, completing insurance claim forms, typing and billing are tasks that administrative staff are capable of doing. Physicians take on these tasks because they feel that if they don't do it themselves, it won't be done. Sometimes, physicians take on non-physician tasks because there is simply no one else to do them.

Advanced access is a series of strategies designed to improve access to primary care services. The starting point is to match care supply to care demand by establishing the patient panel size (the number of patients cared for by the physician). Defining the patient panel serves several purposes. It makes patients happy because they know they have a documented provider relationship. It defines the physician's workload and predicts patient demand. It also enables physicians to make a commitment to continuity of care to a defined set of patients [410, 411, 412, 413, 414]. Physicians can calculate their ideal panel size using Equation (3) [28]. The variables in the numerator are self-explanatory and easily obtainable. The variable in the denominator considers that some patients visit their physician more than once a year. Some patient populations, such as chronic disease patients, palliative patients, or some patients with mental illness, need to visit the office as much as 3 to 4 times per year. Gender and age of the patient panel will also affect panel size [121]. Depending on the nature of the physician's practice, they may be able to take on more or less patients.

$$\text{Panel Size} = \frac{\text{No. of available appointment slots per physician per day x No. of working days per year}}{\text{Avg No. of visits per patient per year}} \quad (3)$$

With patient panel size matched to physician capacity, the next task is to ensure that the right people in the clinic are doing the tasks best matched to their skills. The physician should not be distracted with tasks they don't need to be responsible for. If physicians mind tasks that physicians only can complete, the physician bottleneck is opened and patient throughput is maximized. Physicians should analyze their responsibilities and determine if they hold tasks they do not need to do. Any task which is not a physician task needs to be delegated to more appropriate (that is, sufficiently skilled, but more cost effective) resources within the clinic [175]. This is especially important for physicians as they are the revenue generating resource in the clinic. Other healthcare providers such as nurses can easily handle the non-physician clinical tasks [175, 176]. By freeing physicians of all non-physician tasks, physicians are able to see more patients, increase clinic revenue and drive down patient wait times [177]. When patient wait times are acceptable, patients are less likely to visit an emergency room or walk-in clinic [177]. When physicians see their own, healthcare outcomes are optimized.

Just like it is important to review tasks handled by the physician, it is also important to look at the tasks handled by other clinicians to determine if these tasks are appropriate for them. With a number of tasks being handed off by physicians to nurses, it is important to ensure that the nurses have the available capacity to handle their new non-physician clinical tasks. Nurses are typically more expensive resources than administrative staff and so it is important that nurses and other healthcare providers only carry out the tasks that they alone are permitted to carry out. It is inefficient for a nurse to phone a specialist office to book an appointment for a specialist referral. They don't need to room patients or take calls for appointments from patients. Better uses of their time includes taking vital signs, review of medications, review of family medical history, injections, health screening, dressing changes and suture removal.

The task analysis continues with a review of the tasks handled by administrative staff. As before, it is important to make sure the clinic is making the best use of this indispensable resource. Administrative staff can call, fax, email, schedule, transcribe, and direct. An administrative resource, with just a little clinical background (such as a medical office assistant or licensed practical nurse), can even facilitate triaging patients upon presentation at the clinic. Many tasks can be handled by administrative staff as long as they have the time to do them (often, administrative overhead is the largest expense a physician office will have). To ensure there is sufficient administrative capacity, it may be wise to review administrative duties and consider delegating some to patients.

6.2 Engaging patients in their care

Many industries are saving human resource costs and providing more convenience by delegating administrative duties to their customers. The banking industry has several decades of experience with automated teller machines [415]. The airline industry has reduced expenses in a highly unionized environment by offering customer self-service kiosks for check-in [416]. The grocery industry, where cashiers makeup roughly 1/3 of staff [417], is saving labour costs by using automated self check-out systems. Growing internet penetration, trends in patient empowerment, trends in patient interest in online health resources [418] and electronic medical records combine to help physicians mitigate the rising cost of overhead by delegating basic administrative tasks to patients. One such task is appointment scheduling. A case study reviewing a pilot self-service system implemented by a solo physician practice in a suburban primary care office ran from August 8, 2008 to February 28, 2009 [254, 255, 256]. The purpose of the case study was to understand the online system's impact on physician office performance, its impact on staff, its financial viability and patients' perspective on self-service appointment scheduling.

The self-service appointment scheduling system is often an add-on module to the physician's EMR system. Physicians considering the use of an online self-service appointment scheduling system should have well established EMR based practices (Physicians have restabilized their offices after EMR implementation and are well past Point C in Figure 4-3). An online appointment scheduling system can be used to augment the physician office's $\triangle PV_{Post}$. In this case, the vendor hosted self-service appointment scheduling website uses a VPN tunnel to send plain HTML GET and POST methods over TCP/IP. The site retrieves patient and schedule data from the physician office hosted EMR scheduling module for online presentation to the patient. The system is integrated with the physician's office system so that patient bookings are automatically inserted in the EMR's schedule. Figure 6-1 illustrates the architecture of the online booking system.

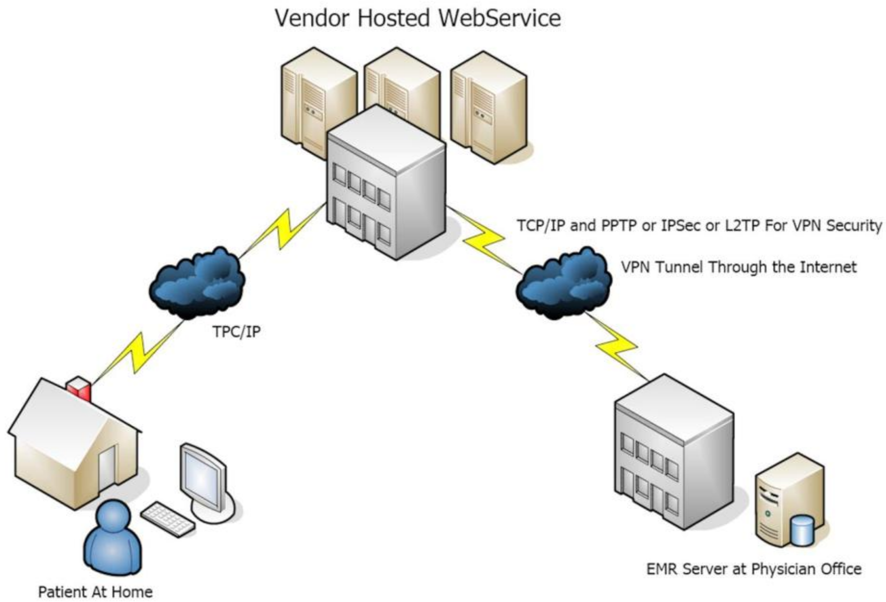

Figure 6-1 – Network topology of an Online Booking System [254]

The author conducted a process engineering analysis of the appointment scheduling workflow for both the conventional telephone booking approach as well as the online appointment scheduling system to compare how the self-service system changed office workflow [254]. A financial analysis was used to create a financial model that could help physicians determine if a self-service system is financially viable in their practice [255]. A 24-question patient survey using closed-ended, Likert scale and open-ended questions gathered perspective from patients who had booked during the period [256]. The survey was tested before starting the study. Inclusion criteria required the patients to be a registered patient of the physician and to have booked an appointment through either channel during the study period. Patients with incomplete mailing addresses or patients under the age of 18 were excluded from the study. The single survey targeting those who booked by both methods was mailed out in groups of 500 or less surveys during the week of April 20, 2009. The first question qualified the recipient as a patient of our physician. The patient was routed through different parts of the survey depending on whether the patient was aware of the online booking system and whether they had actually booked with it. Patients returned the surveys in anonymous, self-addressed, stamped envelopes which were then coded and entered into a statistical application for analysis. Data was synthesized and analyzed using a crystallization approach [31, 32] to find concepts and patterns. Surveys received by May 31, 2009 were included in results. Ethics approval was received from the University of Alberta on April 9, 2009.

6.3 Implications of self-service to scheduling workflow

A workflow analysis of the physician office appointment scheduling function was reviewed with the physician office staff. Figures 6-2 and 6-3 illustrate the results of our workflow analysis. The physician limits the number of appointments he makes available for online booking during a week. Of the 175 appointments available during his week, he made 39 appointments available in the early part of the study (August 8 to Dec 31, 2008) and 57 during the second part (January 1 to February 28, 2009). The total number of appointments that were available for online booking during this study was 592, after accounting for time that the office was closed. The physician and his staff maintained control over which appointment slots would be designated for web bookings. The receptionist could repurpose an online appointment slot for a conventional phone booking if call-in volume required it [254, 262]. To ensure that patients did not abuse the system, the physician instituted a $50 surcharge for no shows (forgiven at physician discretion). Figures 6-2 and 6-3 compare the workflow for the two scheduling systems.

A few observations illustrate the potential value and the drawbacks of an online self-booking system to the operations of a physician office. We noted that the receptionist role (shown as red actions) was substantially reduced by the online system (Figure 6-2 compared to Figure 6-3). The receptionist's activities were shifted to other duties that were either not previously being done, or not done during normal business hours causing the physician to pay overtime to administrative resources [254]. Administrative staff found themselves more available to greet arriving patients. The physician and staff found they could expand tasks to include triaging patients more effectively, taking more time to accurately complete billing or greeting patients on arrival. By shifting receptionist resources away from appointment scheduling, an opportunity exists to justify the system either by cost savings through receptionist dismissal, avoiding overtime pay or by accomplishment of tasks that could only be done by hiring an additional resource [255].

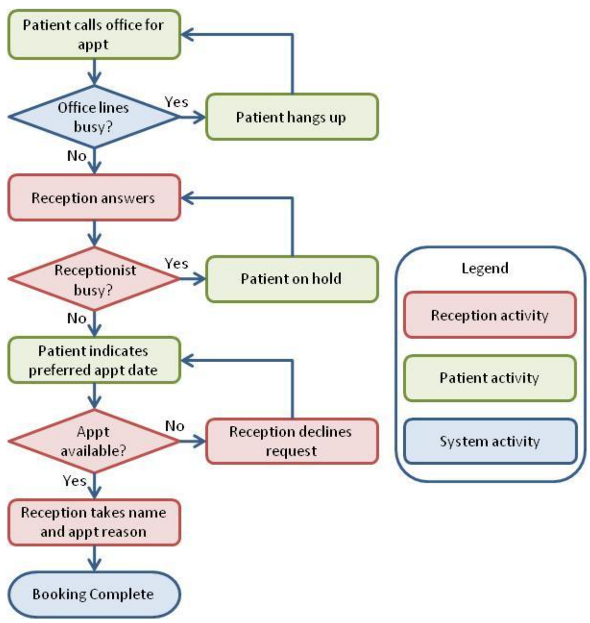

Figure 6-2 – Conventional Booking Workflow [254]

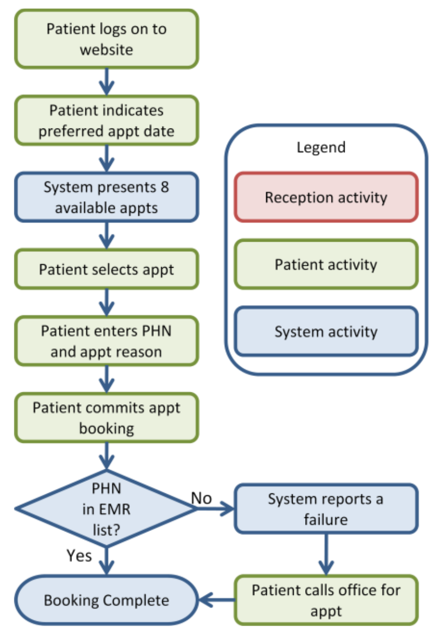

Figure 6-3 – Online Booking Workflow [254]

Before we jump to conclusion though, the pilot highlighted significant drawbacks (Table 6-1). Staff reported that some patients could not reliably access or use the system. As discussed further below, this was due to some patients' unfamiliarity with the concepts of online booking, general unfamiliarity with the internet, not following user instructions, or insufficient user instructions. Staff had to provide technical support to patients when they called for help with online booking [254, 256]. The significance of this drawback cannot be understated. Since receptionists are not technical support staff, they do not have the skills needed to troubleshoot, train or lead patients through the booking process. As a result, receptionists lose a significant amount of time to supporting patients through the process. This distraction compromises the benefits of any time savings intended by the self-service appointment scheduling system and offers a significant amount of frustration to staff. Exacerbating the issue is staff concerns regarding a potential loss of control over scheduling. Staff became concerned about their job security should the system be a success [254, 262]. In the end, the workflow analysis showed that online booking could be very helpful in freeing administrative resources, but success depended on an extremely simple booking interface and well thought out documentation. Practices with predictable and repetitive scheduling workflows benefit the most from self-service systems [254, 262].

Table 6-1: Staff perspectives on a self-service appointment scheduling system [262]

Case Study: **Implementing an online appointment scheduling system**
Benefits of Online Self-Service Appointment Scheduling
• Substantially reduces human resource actions for scheduling
• Allows human resources to do other administrative tasks
• Staff do not need to deal with unpleasant callers
Drawbacks of Online Self-Service Appointment Scheduling
• Staff perceive computer systems as taking away tasks
• Staff perceive computer systems as compromising job security
• Staff perceive loss of control over booking
• Explicit documentation is required to support patients and prevent unnecessary calls to the office

Interestingly, an online appointment scheduling system is reminiscent of the successes seen in the teledermatology study [227]. Both services capitalize on the asynchronous nature of the technology. In the case of the online booking system, the asynchronous booking approach removes the need for patients to make direct contact with the receptionist. As was the case with teledermatology and as is discussed below, this portion of the primary care workflow is easier and more convenient for patients, and results in a better use of time for receptionist and the physician office.

6.4 Financial viability of self-service appointment scheduling systems

Financial constraints are one of the main reasons for the slow adoption of HIT [140, 184, 285, 356, 419]. If the above workflow analysis could illustrate an online self-service appointment scheduling system's ability to reduce the receptionist involvement in the appointment scheduling process, a financial model could be developed to determine the financial viability of the system. Improving access to services is important, but such tools and strategies will not stand the test of time without providing some financial benefit to physicians.

A financial model can be developed by considering the various costs and benefits of a self-service appointment scheduling system [255]. Viability is determined by comparing the costs avoided (additional administrative resources or overtime pay) to the costs incurred in acquiring and implementing the system. The main costs avoided by the system are the costs paid to the receptionist for answering calls. For calculation purposes, we resolved this wage cost to a cost avoided per call. (This assumes that the only task receptionists handle is appointment booking calls, which is not entirely true. Even though appointment calls may be a significant part of the receptionist's day, physicians may need to review or observe the receptionist's tasks to determine the overall percentage of the receptionist's day spent on appointment calls.) The average cost per call is calculated by dividing the receptionist hourly wage (plus a top-up for any employment benefits) by the total number of calls received in an hour. The total calls received in an hour is not a figure typically tracked in physician office HIT systems, but it is a number that can easily be acquired by sampling the number of calls received over several days.

The main system costs considered in this model are those of the online booking system itself. The model assumes that the physician already owns and runs a physician office system. The purpose of the online booking system is to augment the physician's post-transition steady state patient volume or reduce costs. Thus, the analysis weighs the incremental costs avoided against incremental costs incurred. Many vendors sell the self-service system as an additional module that can be added to the physician's existing EMR. Vendors may arrange their pricing structure to charge physicians a single upfront capital fee, a periodic (monthly) subscription cost to use the system or a combination of the two. In our study, the physician chose to limit the number of appointments available for online booking per week to control the pilot. A ratio called the Online Appointment Ratio considers the percentage of appointments made available for online appointment booking. Equations (4), (5), (6), (7), and (8) illustrate these variables [255]:

$$\text{Cost Per Call} = \frac{\text{Receptionist Fully Loaded Hourly Wage Rate}}{\text{Avg No. of Calls taken per hour}} \quad (4)$$

$$\text{Online Appt Ratio} = \frac{\text{No. of appointments available for booking online per week}}{\text{Total No. of appointments available per week}} \quad (5)$$

$$\text{Total Cost of Ownership} = \text{Capital Cost} + \text{Monthly Subscription Fee} \times \text{No. of months} \quad (6)$$

Physicians can determine if the online appointment scheduling system is financially viable by calculating two resultants: the on-going minimum number of calls per month required to recover the monthly subscription fee (Equation (7)) and the payback period needed to recover the total cost of ownership (Equation (8)). Equation (7) calculates the minimum amount of on-going calling activity (minimum number of calls per month) that the physician office must experience to consider the option of an online system. The equation is derived by setting the variable cost of the online system against the variable cost of the receptionist. If the Online Appt ratio represents the calls taken through the online system, the figure (1 – Online Appt Ratio) is the fraction of the call load handled by the receptionist. Clearly, this benchmark is lowered when more appointments are booked online and the monthly subscription fee is relatively low. If the vendor's pricing structure does not contain a monthly subscription fee, then obviously, the minimum number of calls required to meet variable costs is nil. If the physician office's actual number of calls typically received per month falls below this benchmark, then there will not be enough savings (costs avoided) to justify the monthly subscription fees, never mind the total cost of ownership. The physician should stick with the receptionist for the clinic's appointment scheduling function.

$$\text{Min. No. of calls/mo required to cover subscription fees} = \frac{\text{Monthly Subscription Fee}}{\text{Cost Per Call x (1 - Online Appt Ratio)}} \qquad (7)$$

If the physician office's call volume is greater than the minimum calculated above, then the next part of the financial model can determine how long it will take to pay back the system. Equation (8) calculates the number of months it will take to payback the online self-service appointment system. It is derived by setting the total cost of system ownership equal to the total cost of receptionist services. If the analyst wishes to calculate the answer in days, the result of the equation can be multiplied by the average number of working days per month to determine the payback period in units of working days. As shown by Equation (8), the higher the initial capital cost, the longer it will take to justify the investment. Intuitively, the greater the difference between the cost savings and the monthly subscription fee (the denominator), the sooner the system is justified. The more expensive the administrative staff are and the more calls that are made available for booking through the online system the sooner the system is paid back.

Payback Period = Capital Cost / [Cost/call x Actual No. of calls/day x (1-Online Appt Ratio) x Working Days/Month – Monthly Subscription Fee] (8)

6.5 Patients' perspectives regarding self-service appointment scheduling

During the pilot, 7252 appointments were booked by 2476 patients (2348 unique patients booked 7058 telephone appointments while 128 unique patients booked 194 of the 592 online appointments). The two lists of patients were combined into one to facilitate a single patient survey. Patients with incomplete addresses and patients under age 18 were removed from the mailing list. All of the remaining 1959 unique adult patients were surveyed (1831 used the telephone while 128 used the online system to book at least one appointment during the period). Although non-adult patients were removed from the mailing list, 12 surveys were completed by parents on behalf of their children. The data was recorded as if it were returned by the patient. Some patients did not fully complete the survey; again, data was recorded as it was given. Table 6-2 [256] summarizes the results of the pilot. Table 6-3 reports selected survey results by booking channel and Table 6-4 highlights results from those who booked online [256].

Table 6-2: Summary of results from a self-service scheduling pilot

Summary of patients and appointment statistics	Conventional	Self-service
No. of patients	2348	128
No. of appointments booked	7058	194
No. of patient encounters during the study period	5326	156
No. of unique adult patients with complete addresses	1831	128
No. of no shows	157	1
No. of cancelations	597	35
No. of patients who left after registration	1	0

Three hundred and ninety eight surveys were returned by our patients (survey response rate of 20.3%). One hundred and five surveys were returned by patients who booked online (survey response rate of 82.0%). Of the remaining 293, 186 surveys were returned by patients who were aware of the online booking service but still booked using the telephone (10.2% response rate of 1831) while 107 responses were returned by patients who were not aware of the online booking option (5.8% response rate). Two surveys were returned by patients who claimed not to be patients of our physician.

Table 6-3: Selected self-service scheduling patient survey results by channel

Survey Question	Response	Conventional (n=293)	Online (n=105)
Gender	Female/Male	71.1%/74.9%	28.9%/25.1%
Age	0 to 40 years old	18.0%	18.1%
	41 to 50 years old	15.9%	32.4%
	51 to 60 years old	28.6%	21.0%
	61 years or older	37.5%	28.6%
Internet use	At least once per day	74.3%	95.2%
Internet activities	Email	76.1%	96.2%
	Searching/surfing	72.4%	88.6%
	Online banking	46.8%	69.5%
	Making purchases	37.9%	65.7%
	Reading news	47.8%	67.6%
Computer skills (self-rated)	Less than average	24.0%	12.4%
	Average or better	75.7%	87.6%
Education level	Some high school	7.8%	6.9%
	High school diploma	18.5%	11.9%
	Some college or university	16.3%	15.8%
	College diploma	21.5%	23.8%
	University degree	35.9%	41.6%
Years as a patient with this physician	Less than 5 years	20.6%	17.6%
	5 to 15 years	35.0%	45.1%
	15 to 25 years	35.0%	30.4%
	25 years or more	9.4%	6.9%

The survey response rate received from patients who booked online makes us confident that the conclusions offered below represent the perspectives of the total body of patients who booked online during the period. We were somewhat disappointed with the response rate from those who booked through conventional means (293 out of 1831 for 16.0%). Their responses may not be indicative of their population; however, several interesting patterns appeared in the data.

Table 6-4: Survey responses from patients who booked online

Survey Question	Response	Online (n=105)
Easy to get to?	Arrived on first try	61.9%
	Easy, with the right address	32.4%
Easy to use?	Easy	88.0%
	Moderately easy	13.0%
As easy as calling?	Easier	55.8%
	Same	39.4%
Reasons for booking online?	Convenience	61.6%
	Telephones too busy	6.4%
	Prefer to do things myself	6.4%
	Offered more privacy	5.6%
Would you use a physician supported patient health record or portal?	Yes	76.0%
	Maybe, depends on security	17.3%
	No	6.7%
Overall satisfaction	Extremely satisfied	44.7%
	Satisfied	53.4%
Received email reminder	Yes	41.8%
Would you use the online system again?	Yes	100%

Most survey respondents were aware of the online booking service (n=291, 73.1%), seeing a wall mounted poster describing the system (n=113, 39.0%) or hearing from the physician's staff (n=70, 24.1%). Of those respondents who booked via phone, 28.8% (n=53) learned of the online system at their most recent visit. One hundred and fifteen of those who booked by telephone would consider booking online in the future and 20.1% (n=37) said they still planned to book via phone (they indicated that they prefer talking to a person rather than using a computer to make appointments). Patients reported other reasons for booking appointments via phone [256]:

- Patients wanted to book online but could not navigate to the website (n=15, 8.2%),
- Patients didn't own a computer or have internet access (n=13, 7.1%),
- Patients simply did not know how to book online (n=9, 4.9%),

- Patients tried to book online but there was limited choice in the appointments available online (n=8, 4.3%). We noted that 21 respondents who booked online also reported that they were dissatisfied with the number of appointments they could select from.
- A small number of respondents (n=3, 1.6%) reported that the cancelation fee discouraged them from booking online.

We hypothesized that a significant difference existed between the age of patients interested in booking online and the age of those who booked by phone. Our naive assumption stemmed from conjecture that senior patients would not have the computer aptitude or internet experience to successfully book an online appointment. We also believed that concerns regarding security and confidentiality would cause older patients to select phone booking. However, most of those who booked online were older than 40 years old (81.6%). A Chi-square test revealed that the propensity to book online was dependent on age (Chi-square=17.1, p<0.009), however, some skew may result from the exclusion of patients less than 18 years of age. A visual review of age distribution of respondents showed the age of those who booked online (Figure 6-4) to be similar to that of those who booked via phone. Despite the Chi-square results, we can only conclude a tendency to favour or avoid booking online pertaining to age *for an adult population* [256].

We compared the two respondent groups based on frequency of interaction with the internet and self-rated computer aptitude. A large number of respondents from both groups report using the internet (74.3% of respondents booking by phone and 95.2% booking online) at least daily. More respondents who booked online use the internet several times per day (78.8% of all respondents who booked online compared to 55.6% of respondents booking via phone). Not surprisingly, a Chi-square test demonstrated that there was a dependent relationship between a likelihood to book online and frequency of internet usage (Chi-square=29.5, p<0.001). The internet plays a larger role in these patients' lives, leading us to conclude that those who use the internet for day to day activity are more likely to use it to book an appointment with their physician. A dependent relationship also materialized when we examined the two groups for self-rated computer aptitude scores (Chi-square=26.8, $p<0.001$). Computer aptitude provides the confidence needed to try the online booking system [256].

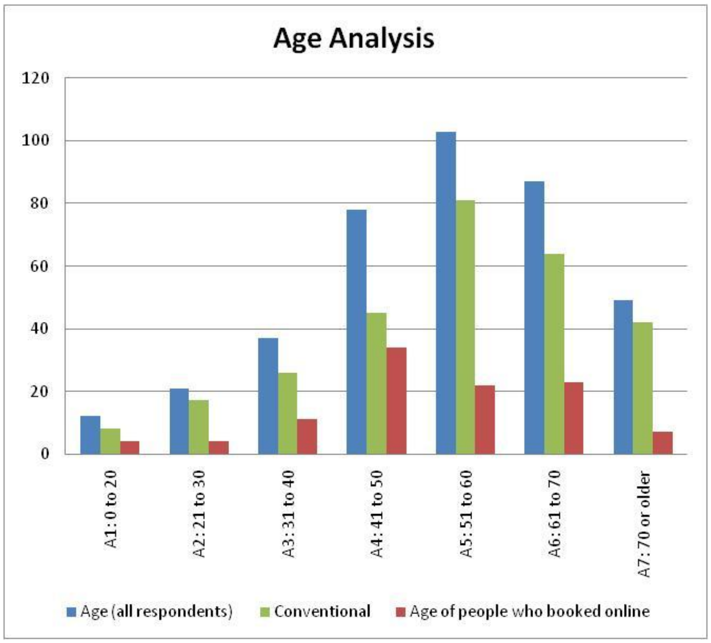

Figure 6-4: Age distribution of self-service scheduling survey respondents

We also reviewed the two respondent groups based on education level and number of years as patient with our physician. No significant relationship between the two groups' education levels (Chi-square=2.81, $p<.59$) was found, even though the education level of those who booked online was slightly higher than those who booked via phone (Figure 6-5). Similarly, there was no dependent relationship between a patient's likelihood to book online line and the length of time they had been a patient with our physician (Chi-square=8.95, $p<.255$) [256].

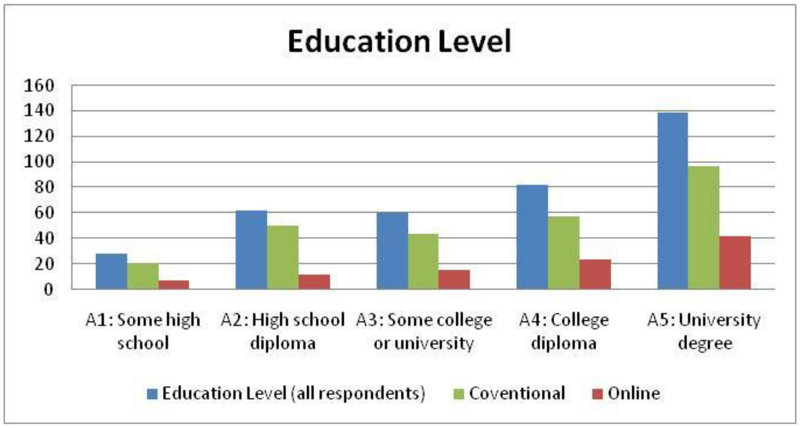

Figure 6-5: Education distribution of self-service scheduling survey respondents

We wondered whether a perception that internet services could be insecure would discourage patients from booking online. Interestingly, only 4.3% (8 out of 176) of respondents who knew about the online system yet still booked via phone indicated that their concerns about the privacy of internet systems prevented them from using the online system. Further, 5.6% (n=7) of respondents who booked online did so because they wanted to avoid the possibility of having to discuss the reason for their appointment with the receptionist. All respondents were asked to consider if they would use a "highly secure website" to access their health information to which 61.3% (n=100) of those who booked via phone and 76.0% (n=79) of those who booked online responded positively. Any perception of insecurity in internet systems does not seem to discourage these respondents from using online personal health information systems [256].

As discussed previously, the study exposed some system design issues. The address for the online booking system is not prefixed with the traditional "www" prefix of a uniform resource locator (URL). Despite clear instructions for the address on posters, leaflets and the after-hours telephone greeting, 8.2% (n=15) of respondents tried to book online but erroneously typed the "www" resulting in an inability to navigate to the site. Of those who did book online, 32.4% (n=34) had trouble with the website address before successfully navigating to it. Many had to call the office to confirm the address. The online system confirms the physician as the patient's care giver by PHN and telephone number. Both numbers are entered without "-" separators (Alberta's PHN number has a xxxxx-yyyy format); however, our pilot site does not inform patients of this requirement. Several patients also called the office looking for clarification on this matter. Our patient surveys corroborated the frustration the receptionist experienced, the wasted receptionist time and the eroded value of self-service [254, 256].

Despite the issues reported above, 95.2% (n=99) of respondents who booked online found booking appointments online to be at least as easy as booking by telephone and all of them indicated they would use the online booking system in the future. They indicated that online booking was faster and avoided risk of being put on hold for extended periods of time. Convenience was the most popular reason for patients selecting to book online although many indicated that they saw online booking as an opportunity to take control of the booking process. Patients booked appointments in the evening hours when the office was closed. Patients preferred booking online because they were offered more appointment choices (the system offers 8 appointment times where as our receptionist tries to save time on the phone by offering only one or two appointment choices), although some wanted still more choice.

An online self-service appointment scheduling system can be a viable solution which helps the physician office become more efficient by delegating appointments to patients. By delegating a small task such as appointment scheduling, patients play a small role in their own care. Receptionist resources are opened up to take on tasks delegated from elsewhere in the clinic, which ultimately frees physicians from non-physician tasks. Online systems require an existing physician office system to be well entrenched in a physician office workflow. Physicians who have already stabilized their practices after adoption are ideal candidates for self-service systems. Practices with predictable and consistent scheduling workflows benefit the most from such systems. Online booking may not be suitable for use by all patients because of computer skills, internet access or concerns over privacy and security. Still, those who book online reduce call volume to make the physician office more accessible to patients booking through traditional methods [420].

6.6 Conclusions

Several industries have started to involve clients in service delivery. Advanced access is a physician office strategy for increasing capacity to deliver care. Advanced access advocates for the assignment of tasks to the best skilled and most cost effective resource. Patients can play a part in service delivery through an automated appointment scheduling system. Our workflow analysis shows that online appointment scheduling can virtually eliminate the receptionist's role in scheduling, freeing them for other administrative tasks. If the online appointment scheduling system's variable costs are lower than the receptionist's pay, our financial model demonstrates that a business case can be made to invest in an online scheduling system. Our patient survey showed that patients with strong computer skills and who make frequent use of the internet will use online scheduling for convenience, choice and control. While online scheduling is not for everyone, those who book online make the physician office more accessible for those who will continue to book through traditional means.

Chapter 7 – Implications for the Role of Physicians

7.1 The changing role of physicians

The above chapters discuss many effects that HIT has on various elements of healthcare, but HIT also has a profound effect on the physicians themselves. When people choose a career in healthcare, it is usually because they want to make a difference in peoples' lives. They want to help people. Physicians pursue in-depth training in the art and science of healthcare. They spend all of their time studying systems of the body, pathologies, diagnoses and strategies for addressing ailments. Senior practicing primary care physicians did not spend much time learning how to use information systems, developing their organizational leadership skills or making large scale organizational decisions. Yet, here, as the healthcare industry proceeds to adopt information technology, we ask physicians to take on new roles. With little to no training, physicians are asked to set aside their daily practices to implement HIT. Hanging in the balance is the health and welfare of the patients, and their own job satisfaction.

HIT adoption requires physicians to take on many roles. Role change is not necessarily anticipated or welcomed by physicians. Why are physicians faced with these changes? Why physicians and not other healthcare providers? Physicians hold the senior role in healthcare. They have the greatest range of practice scope. They are legally responsible and liable for the care of patients. They wear this responsibility with great pride, but they also take great responsibility to protect themselves and their patients. To some of us, they may appear reluctant to change. It is not necessarily the case. Still, change is inevitable and jurisdictions as well as physicians must consider changes needed to meet the new demand for care. Physicians' professional lives are full of change. Chapter 2 testifies to that. If healthcare projects are to be successful, physicians must be involved in the adoption of HIT. This is not necessarily because physicians have all the answers. Without the physician leadership and involvement described in Chapter 4, physician buy-in will not exist. Solutions have less chance of fitting into the care delivery environment.

Figure 7-1 illustrates that for HIT projects to be successful, physicians need to sponsor projects. Project sponsorship means that the physicians endorse the work. They agree to foot the bill not only in terms of the direct financial cost of purchasing the system, but the unseen costs of frustration and anxiety that they and their team experience during transition. When new HIT is taken on, not only does the organizational workflow and culture change, but physicians' leadership strengths also mature.

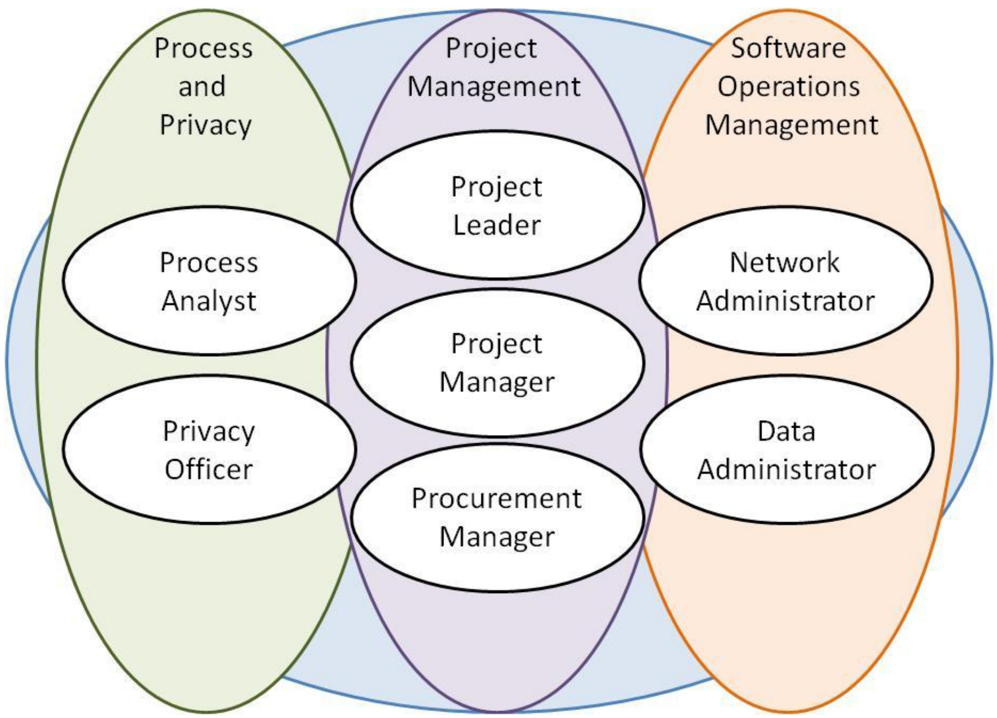

Figure 7-1 – The Modern Physician

Primary care reform models are the essence of change. The adoption of interdisciplinary team based care places an immense leadership load on physicians. Physicians are contributing to the development of new business plans for PHOs, IHNs, FHTs and PCNs, when they have never developed a business plan for their own practices. Physician leaders are being asked to articulate a vision for care delivery and lead their employees, their colleagues and themselves to that vision. They are being asked to develop new workflow processes to operate an interdisciplinary team when they have not worked with anybody other than a receptionist. Physicians wonder about their own role in care delivery as other clinicians' responsibilities have expanded. Given the declining physician supply, we can expect physicians to become more like care consultants to OHCPs and less like the primary caregivers of the past. Studies show that successful HIT implementations are supported by executives [171, 246, 278, 292, 294, 295, 306, 307, 308, 421, 422, 423, 424]. Studies found that assigning a physician to champion a project also led to success [246, 273, 295, 296, 297, 301, 324, 422, 425]. While the studies advocated physician leadership, a team approach is critical during design, development and implementation phases [167, 171, 246, 273, 292, 296, 297, 298, 299, 300, 301, 302, 303].

Another significant role change implication for physicians is that of project manager and procurement officer. HIT implementations are projects which benefit from project management skills. As project leaders, physicians sometimes need to be able to develop a project timeline and manage to it. Project risk management and project procurement management are discussed at length above. To expect physicians to have strong knowledge of project management is unrealistic, yet as private independent business owners, they are largely left to their own devices to effectively implement a system. Jurisdictions do well to implement certification and conformance organizations which offer support services to help physicians through this process.

Physicians have new IT responsibilities as owners of computer systems and custodians of electronic health information. Certainly in the past physicians have had to develop their own knowledge of IT software, then how to run it and maintain it. This is not as much an issue any more with the advent of ASP EMR delivery models, but physicians still need to know how to use the software. They may need to know how to teach the software to others on their team. They need some familiarity with how to set up and operate computer networks. They need to be able to understand the concepts of a database and how their EMR reports can be used to extract population data or patient health data that can be used to improve the quality of their care. They need to be able to use the software efficiently to communicate with their fellow clinicians and direct their patient care tasks. They need to maintain the software as well. Managing software updates, patches, compatibilities with operating systems, and browser versions have now become part of the everyday vocabulary of the family practitioner.

Physicians' IT role extends beyond networks and databases to the actual software. More and more physicians are involved in the design of the software itself. Software product managers must ensure that physicians are consulted in the design of clinical software so that the workflow inspired by the software is sound clinical workflow. Physicians are part of the leadership team in several software companies [426, 427] and also involved in the RFP development process and the conformance testing [397, 428] in several certification companies to ensure the software that makes it to market will support the clinical needs of the physicians in the market.

It is interesting how patient privacy has become a significant issue in the electronification of the physician office. Paper systems are not immune to privacy and security risks, yet, physicians find themselves in the new role of privacy officer when they choose to adopt HIT. The privacy officer's role is serious business. Before physicians implement new information systems, they must consider their impact on patient privacy [305, 378, 429, 430, 431] by completing a Privacy Impact Assessment (PIA). Privacy officers need to articulate their organization's ability to protect patient data, which is accomplished largely by documenting their computer system and network security features. The PIA ensures that each physician has performed due diligence to identify and mitigate privacy risk factors inside, or outside, of the clinic environment [305]. It assesses the physician office's ability to meet the obligations for collection, use and disclosure of identifying personal health information [305]. The physician as privacy officer, in a private primary care practice setting, is ultimately accountable for information security breaches. This can be a scary prospect and an inhibitor to adoption for physicians who do not understand technology. Completing a PIA is a long and complex task. Responsibilities vary depending on the nature of the implementation (ASP vs. locally hosted implementations). A physician must be intimately familiar with his/her computer network to complete a PIA. PIAs require technical knowledge that not all physicians have. Furthermore, the obligation to complete a PIA takes away from the everyday tasks of seeing patients. PIAs are a requirement stimulated by the adoption of health informatics, but physicians using paper information systems have the same obligations to maintain patient privacy. PIAs are an example where health informatics is more than a tool like paper.

7.2 Conclusions

Our review concludes that there are a number of role changes that result from the adoption of electronic health information systems. Are physicians ready to take on these roles? Certainly, it is unrealistic to expect physicians to take on these responsibilities. Some physicians are ready, but many are not. Do they see these “administrative” roles as distractions from the real reason for which they entered care? Do physicians have the time to develop the required skill and knowledge to perform in these roles? Does their waitlist prevent them from taking the time needed to properly select a system? Physicians need support in these new roles. In Alberta, Primary Care Networks offer a unique infrastructure to support physicians in their adoption. PCNs centralize tasks by hiring resources better skilled for several adoption activities. PCNs can provide project management, contract management and procurement management support to physicians. Some PCNs are already providing basic computer training and IT technical support to support the non-EMR related support issues (networks, printing, files, hardware support). PCNs can provide human or financial resources to physicians for converting paper based records to electronic form. PCNs can also provide funding and coaching office space leasehold improvements/renovations for a better patient-provider experience.

Chapter 8 – Concluding Discussion

8.1 The effect of information and computing technology on healthcare

8.1.1 Socio-technical implications of ICT

Socio-technical factors affect HIT implementation success. A mature organizational culture is the derivative of an organization's very distinctive and unique healthcare delivery experience. A culture is a collection of the beliefs, norms, and values, spoken or unspoken, that form the basis for the patterns of behaviours in the organization [265]. Since different organizations have different operational contexts (populations, health issues, staff, skills, geographies, policies), a wide range of practice approaches and possibilities may exist. Understanding the existing culture is critical to understanding how it will be affected by technology induced change. Health informatics can have an enormous effect on organizational culture and workflow. Product managers collect feedback from many users and use it to build product features and functionality. Thus, HIT can be seen as a projection of how a specific software firm and its users believe such tasks should be carried out. Unless the software is custom developed specifically to fit the workflow of the target environment, its workflow will likely differ from that of the target organization [266]. The degree to which the workflow of the software matches the workflow and culture of the organization is referred to as the "fit". The degree of fit, or better, the lack of fit, can have a significant effect on the operations of the clinic.

Several risk factors cause uncertainty when transitioning from the pre-existing workflow to the workflow which exists post-transition. Privacy [279], patient safety [150, 151, 173, 174, 280], provider-patient relations [337], staff anxiety [160], time needed to implement [199, 278, 281, 282, 283], quality of care, financial [184, 284, 285], efficiency, and liability [140, 227, 258] factors are risks that must be managed for implementation success. When workflow changes compromise organizational predictability, the lack of coordination may result in misdiagnosis or mistreatment. Quality of care is compromised. The more socio-technical conflict between pre-transition workflow and that required to operate the software, the more likely these risk factors will compromise the implementation. Clearly, the health information systems themselves are not the source of adverse medical events, but rather the incompatibilities between new systems and previous workflow precipitate the errors. Strong physician leadership [171, 246, 278, 295, 306, 307, 308, 309], project management [272, 273, 275, 280, 293, 295, 306, 310, 311, 312], standards and staff training [167, 171, 199, 278, 281, 282, 283, 303, 307, 309, 310, 313, 314, 315, 316] lead to long term adoption.

HIT implementation can cause both short and long term impact on physician office performance. In the near term, the physician office may experience a drop in patient throughput as the clinic adapts to the HIT. Temporary (but not implying short term) confusion resulting from new workflows and procedures inferred by new technology can compromise office efficiency and patient safety. Recovery begins when project leaders realize the difference in workflow processes between previous practice and that needed to integrate the new system into the organization. The rate of restabilization is a function of physician computer skills, exam room layouts, the complexity of the graphical user interface, and the amount of training available [253]. Exam rooms may need to be reconstructed to ideally place the computer monitor such that physicians and patients can maintain eye contact during the patient encounter. As physicians grow accustomed to the new software, develop their computer skills and receive training on the system, they become more efficient in their data gathering [351] and clinical decision making. It is possible to calculate the cost of the HIT implementation by including cost of the transition with the cost of computers, software and training. Physician owners are able to determine when the system will pay itself off and thus determine if it is financially viable to adopt HIT.

In the long term, HIT may support physician office efficiency, although this hypothesis still requires more analysis. Advanced users of HIT can leverage it for additional benefits such as online self-service (appointment scheduling, registration, family histories and other administrative work). HIT can facilitate quality assurance processes by supporting the peer review and second opinion processes. Clinical decision support tools prompt clinician activity, which is especially helpful in busy, chaotic environments [359]. Implementers need to be aware of the failure modes which can compromise patient safety and quality. HIT changes the way clinicians work with each other and organizations share health information. Just as adverse data and medical events resulted from insufficient inter-application design and testing in the Alberta EHR [193], changes to the physician office workflow can cause changes to interdisciplinary clinical communication [150, 275, 357]. Thus, quality of care is not adversely nor positively affected by health information systems themselves [258, 358, 359, 364, 365]. Rather, it is changes to the processes that surround information management and the resulting temporarily uncoordinated workflow that lead to breakdowns in care delivery. HIT can improve the quality and safety of healthcare, but implementers need to understand where breakdowns have occurred in the past and manage for them. Standardization on technology usage followed by staff training helps to improve coordination of integrated care [193, 253]. Adopting rigourous software operations approaches helps to coordinate the amount of technical change.

8.1.2 Software Operations, Procurement and Certification

There is an integral relationship between the physician office health information system and the jurisdictional electronic health record. The EHR depends on technical and semantic integration with physician office systems, and other point-of-service systems, to collect patient health information. Similarly, physician office systems integrated into the jurisdictional infostructure depend on accurate health information for clinical decision making at the point of care. HIT affects the way jurisdictions work with each other to share aggregated patient information just as electronic medical records change the way clinicians work with each other to deliver care to an individual [193].

Several independent healthcare organizations hold responsibility for component application delivery for Alberta's EHR. Several adverse medical events resulted from uncoordinated software operations involving interdependent applications operated by these separate organizations. The jurisdiction has since adopted Change and Release Management processes from the Information Technology Infrastructure Library to manage and protect inter-application dependencies.

The risk faced in developing customized, distributed EHR software is mirrored by the procurement risk assumed by physicians in purchasing COTS physician office systems. Physicians are unfamiliar with how to properly evaluate, select, implement and adopt a physician office system [161]. Few physicians have the knowledge, skills, experience or the confidence needed to run a project [161]. Physicians can minimize their procurement risk by undertaking several simple, but time consuming tasks. They are advised to draft requirements for a physician office system. They can gather product information from vendors to learn how the product features address their requirements. Physicians may consider delegating project management tasks to a project manager who can facilitate procurement and act as a liaison between the physician office and the vendor. Operational risk can be managed by standardizing the clinical terminology, lab test results ranges, the way the system is used, as well as the type of information saved in a physician office system. Training staff to use the system consistently helps to ensure coordinated clinic workflow.

Some jurisdictions have addressed adoption risks by creating certification and conformance agencies that are responsible for facilitating adherence to jurisdictional health informatics objectives. These agencies mitigate procurement, liability, financial and operational risks for physician offices and facilitate integration with a jurisdictional health information system [167, 215, 258]. Certification and conformance organizations facilitate HIT adoption by regulating the GP systems markets, by pre-testing vendor products against standards (Jurisdictional Certification Process) and by providing procurement support to GPs (Physician Procurement Process). As a result, these organizations offer an immense amount of influence in the health informatics arena. Certification organizations centralize a number of responsibilities, thereby lifting them from physicians' shoulders and, arguably, placing them into the hands of more qualified resources. They create buying power by coordinating demand for health information systems from otherwise disparate physician offices and facilitating procurement through formalized procurement processes. Failure to achieve certification in a jurisdiction may result in significant marketing disadvantages or even ejection from the market.

Factors reported to influence adoption success in international jurisdictions are the degree of health system centralization [400], a mandate for electronic billing [193, 400], electronic prescription writing and adjudication [193, 400], quality based incentives, transition support, and peer support [78, 400]. Table 2-1 above illustrates that widespread HIT adoption can be facilitated with a number of general practice remuneration models. Still, some jurisdictions have attempted to stimulate adoption by offering reimbursement programs in conjunction with their certification programs. Reimbursement models offer some respite from the shortfalls of the FFS remuneration model which may incent physicians to focus on patient throughput to the detriment of tasks needed to make informed decisions about their health information systems.

8.1.3 Advanced Access and Office Efficiency

Primary Care Reform provides strategies for balancing healthcare supply and demand at the jurisdictional level. Advanced access uses simple methods to match supply to demand at the physician office level. Physician office supply can meet demand by appropriately sizing the physician office panel. The most efficient use of resources is achieved by properly assigning office tasks to office staff and simplifying the scheduling function. Some tasks may even be best handled by patients. A simple online self-service appointment scheduling system can engage patients in their care by involving them in a simple healthcare responsibility [254, 255, 256]. Patient self-service appointment scheduling frees up receptionist resources to complete other tasks that may have been historically performed by other clinical staff or may have to wait until after hours. Some patients appreciate the ability to book appointments when it is convenient for them [256]. However, not all patients are ready to take on such responsibilities [254, 256]. Patients with the computer aptitude and internet experience will use the system more [256]. If online self-service solutions are to become a suitable alternative for a more general population, systems need to be simply designed and well documented [254, 256]. Otherwise patients simply call the office for technical support, a role that receptionists may not be prepared for. A well designed system can save physician office resources and pay for itself through cost avoidance [255].

8.1.4 Implications for the Role of Physicians

HIT has a profound effect on the role of physicians. It is important to acknowledge these new roles as they, to some degree, can be expected to erode the amount of time physicians have available for patient care. Studies have shown that physician involvement, and indeed leadership, is a necessary ingredient to HIT project success [246, 273, 295, 296, 297, 301, 324, 422, 425]. Physicians are involved in business planning for integrated interdisciplinary health teams. They become project managers for leading the evaluation, selection and implementation of HIT. They are involved in the procurement of the software. They are responsible for privacy of patient data which requires them to become knowledgeable of computer system security and network topology.

8.2 Methods

Deliverables from several courses were used to generate series of articles submitted for publication in scholarly journals. Ten articles were produced and published (all of which have been accepted or published at this writing) in peer reviewed journals to share the findings of our studies. The author had several opportunities to sound the above concepts out with other members of industry and academia through conference speeches and poster presentations. These papers were purposely researched with several different co-investigators to benefit the student from the research skills and interests of others. These papers were purposefully researched using several different methods to gain experience. Literature reviews, semi-structured physician interviews, semi-structured patient interviews, patient surveys and observations were used to gather information. Three literature reviews were used to develop foundational knowledge regarding specific aspects of health informatics. Four articles leveraged semi-structured interviews to gather information from actors in the healthcare system or to gain perspectives from patients. One article used engineering workflow analysis to understand the effect that information and computing technology had on physician office performance. Another used a patient survey and statistical analysis to understand patients' perspectives regarding self-service appointment scheduling. Where appropriate, the researcher contacted industry informants to gain information. The researcher's work experience as a healthcare executive offered the opportunity to qualify research findings with industry context.

8.3 Critical Appraisal

Of the 10 studies conducted to inform the research presented in this dissertation, 3 articles used literature reviews to form the foundation for the program. Their findings were based on reviews of the health information adoption experiences in countries with leading health informatics programs. These reviews were limited because only one analyst reviewed findings. There was no opportunity to review findings and conclusions with other resources. The researcher did not have the chance to examine how health informatics affected healthcare delivery in other countries. Examining the health information systems adoption experience in countries in formative stages of their programs could have uncovered interesting findings still relevant in countries with senior programs. Literature reviews were limited to English language articles which may have restricted findings.

This program was well informed by research that gathered information from the perspective of primary care physicians who are leaders in health information systems adoption. Our studies (except one) did not posses enough power to be statistically significant, although theme saturation was reached before interviews were completed. Physician leaders may not reflect the perspectives of their associates. Inclusion and exclusion criteria may have excluded physicians who could have offered other opinions. Only Alberta physicians who participate in 2 PCNs were interviewed. Even though more than half of physicians in Alberta participate in PCNs [432], some of our findings may not be relevant to physicians who fall outside of PCNs.

We would have liked more opportunity to discuss our studies with patients. Although we surveyed patients as part of an online self-service appointment scheduling system and interviewed them in an evaluation of a teledermatology clinic, we would have relished the opportunity to study the drivers and influencers in the adoption of PHRs. The integration between PHRs and EMRs represents another opportunity to engage patients in the delivery of their care and to make physician offices more efficient. Studies could have benefited from observations of physician-patient interaction. The large survey response rate of those who booked online gave confidence that the results represent their perspectives. Only a small response rate from patients who booked via conventional telephone methods was received and thus, these findings may not be indicative of that population. Low usage of the online booking system may have resulted from an inadequate means of informing patients about the system or insufficient time to inform patients of the system before starting our study. The simple implementation compromised some patients' ability to successfully book an appointment. Online booking in a solo practice is inherently simpler than online booking for a multi-physician clinic; some of the findings may not be applicable to group practice.

The health informatics adoption experience in other Canadian provinces was not directly studied. Given the strong and recent changes in the governance structure in

Alberta, some of the above findings may not be entirely applicable to other provinces. POSP is now a mature certification and conformance program, but to the extent that the above studies were conducted in the Alberta context, some conclusions may not yet be applicable to more junior programs in other provinces or countries.

These studies focused on the health informatics agenda in primary care. Although one literature review extensively examined the health information systems adoption experience in other domains of care, more insight into the drivers and influencers of health information systems adoption could have been found if there was an opportunity to study other domains of care directly. Considering the low adoption rate of health informatics in North American hospitals [206], an opportunity exists to determine why hospital information systems have not proliferated. Given the different job contexts that specialists work under, it would have been quite interesting to examine the drivers of health informatics adoption in specialty care.

Certainly we have analyzed how health information systems can support primary care reform as it addresses the growing epidemic of chronic disease. We did not consider other health trends which drive the adoption health information systems. We spent no time examining the role health information systems plays in supporting the increasing demand for mental health services. Mental health remains a significantly underserved area of primary care, where up to 60% of people visiting their primary care office have a mental health concern [433, 434]. We also spent very little time understand how health informatics supports population health and public health strategies. We spent no time looking at how health information systems supported healthcare business intelligence programs.

This program of study spent no time analyzing the specific aspects and designs of interoperability standards. A simple transition from HL7 v2.x to HL7 v3 (to name but one example) offers significant impact that software engineers and physician adopters must address. An opportunity remains for engineering resources to be applied to understanding the current interoperability standards and the migration plan that governing bodies have in store for them. There is no doubt that these changing standards will only aggravate the implications that have been described in the above chapters.

A number of theoretical and financial models are presented in this dissertation. These models are born of the immersion and crystallization approach used in analyzing the information harvested from our various studies. While these models do well to communicate the concepts that come from crystallization, they still require further validation to make them more realistic.

8.4 Conclusions

We set out to understand the effect that information and computing technology brought to primary healthcare. We wanted to know how physician liability affected adoption. We were interested in understanding how remuneration and reimbursement affected adoption. We wanted to study the role that telemedicine could play in facilitating specialist referral, quality assurance and patients' access to services. We hypothesized that physician office systems brought inherent, obvious value in efficiency, thus physicians would not hesitate to purchase such systems. However, the above dissertation details the barriers to adoption that exist for physicians considering adoption.

8.4.1 Telemedicine

Telepathology and teledermatology were both reviewed to understand how telemedicine could improve quality assurance processes, the referral process for family physicians and access to services for patients.

- Currently, telepathology only interests early adopters.
- Pathologists' skepticism about telepathology is related to factors such as liability, data security, costs and image quality. Primary care physicians have the same concerns about teledermatology.

- Store and forward asynchronous teledermatology makes a dramatic improvement in access to services for patients, but referring physicians are concerned about their liability if they follow the recommendations of a dermatologist who has not seen their patient face-to-face.

8.4.2 Socio-technical Factors

Physician office systems are thought to be one solution to the growing gap between patient demand and physician supply of care. HIT implementations are not simple technical projects. Significant cultural and organizational upheaval may result from a mismatch between an organization's workflow and that demanded by its new software.

- Change management and mathematical models presented in this dissertation quantify substantial costs related to socio-technical change management factors which were not previously easy to quantify in return on investment calculations. These costs are in addition to hardware, software and training costs.
- The total cost of adoption is high, such that physicians, left to their own devices, do not choose to adopt physician office systems. Physicians and their staff 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 if leadership, project management, training, and standardization of terminology are used to improve their chances of success.

8.4.3 Procurement

Physicians do not follow a well developed and consistent process for selecting physician office systems for their practice.

- Physicians in smaller suburban physician offices tend to minimize their market scanning, requirements gathering, implementation and training efforts.
- Family physicians practicing in urban, academic or hospital settings spend more time networking with colleagues to understand the vendor market. They devote funds to a non-clinical project management resource to drive implementation through a planned, incremental implementation approach.
- There is no clear relationship between family practice remuneration model and physician office system adoption. Rather, stronger physician professional networks used in information gathering, more complete training, a managed approach to implementation and in-house technical support appear more influential than remuneration model in facilitating the adoption experience.

8.4.4 Certification Organizations

Jurisdictions can help physicians through adoption by assisting in the procurement process. Certification organizations mitigate liability, procurement and financial risk to qualifying family physicians.

- These organizations pre-qualify vendor solutions, coach physicians through their procurement process and provide reimbursement to qualifying family physicians purchasing an approved physician office system.
- Certification organizations are advised to limit the number of approved systems to a range of 3 to 6 systems. Too few systems does not provide the choice or competition needed to support physician satisfaction while too many systems imply high costs for organizations who remain fiscally responsible to constituents or physician members.
- Certification organizations should tie physician reimbursement for systems adoption to usage or to reporting quality of health outcomes. Relating reimbursement to usage or reporting quality performance drives EMR

adoption, supports quality of care, reduces errors, and increases healthcare system efficiencies.

- Jurisdictions should control the frequency of systems patches and upgrades. Jurisdictions might consider implementing a release management process similar to ITIL to mitigate risks pertaining to software operations.
- Certification organizations are an example of how centralization tends to facilitate adoption of HIT. Centralization helps to minimize the need for data, software development and operational standards in provincial EHRs. Centralization makes small EMR markets more attractive for EMR vendors.

8.4.5 Involving the patient in their care

Online booking is an example of how physicians with advanced physician office system implementations can delegate scheduling functions to patients.

- Online scheduling can reduce the human resource requirements used in scheduling, if the system is well implemented, well documented and easy to use.
- Patients booked appointments online because of convenience, control and choice. Patients who have the computer skills and internet
- experience will select online booking as a preferred booking method. Online booking may not be suitable for all patients, but those who book online leave the physician office more accessible for those who will continue to book by phone.

8.4.6 The changing role of physicians

The software nature of HIT brings new responsibilities to jurisdictions and physicians. While patients do not seem to exhibit great concern over privacy, physicians and jurisdictions have new responsibilities for patients' privacy protection.

- Suburban physicians play a project manager role when adopting systems for their offices.

- They also take on network, database and hardware support responsibilities.
- As leaders of primary care reform, they also must lead the adoption of interdisciplinary teams while maintaining their own office practices.
- Not all physicians are ready for these role changes; Alberta's primary care networks are an opportunity to facilitate this role change.

8.5 Future Studies

8.5.1 Validation of financial and change management models

This dissertation presents a model for conceptualizing the effect that information and computing technology has on primary care. Figures 4-3 and 4-4 depict the interruption that a change in process produces. The model is a sum of the descriptive discussion in the literature and the findings from our own studies. A useful investigation would be to quantify the model to determine its accuracy. For example, some studies attempted to quantify the drop in patient volume at Point B, but many studies could only make qualitative estimates. Physicians interviewed in our own studies could only make qualitative estimates as one of several discussion points in a semi-structured interview. A study which tracks the fluctuations in patient volume would offer insight into the model, which could then be modified according to captured data. It could track the drop in patient volume at Point B as well as the duration of destabilization and restabilization. It could determine if $\triangle PV_{Post}$ can be positive or negative and the factors that cause such to occur. No doubt that it would illustrate that the destabilization and restabilization trends are not simple linear patterns. They likely contain oscillations that illustrate trials and successes as a practice adapts to its new information management processes. Several studies could be used to quantify the model. One series of studies could be engineered to examine patient volumes for practices transitioning from paper to HIT. A second series may examine transition from one HIT system to another. The current consolidation of EMR systems for sale in Alberta would offer a unique opportunity because several physician offices may transition from systems which have been made ineligible to newly certified systems. Another set of studies could examine how the model fluctuates if the implementers use a big-bang approach instead of an incremental approach. The challenge in designing these studies will be to control for confounding factors. Multiple implementations would be needed to compare one practice to another's experience in transition. They would need to control for physician computer skills, exam room layouts, product differences, and practice dynamics. Funding for these studies would be an issue as would the time needed to complete them.

8.5.2 Remuneration and reimbursement

There is more opportunity to investigate how remuneration and reimbursement models combine to affect health information systems adoption. We have explored a number of reimbursement strategies in countries with high levels of adoption [215]. The literature and our two studies [78, 161] were inconclusive in describing the combined effects that remuneration and reimbursement offer adoption. A new approach would be to consider conducting the studies described above again but with more physicians. Again, we would conduct similar semi-structured interviews in small, large, academic and hospital based primary care facilities. We might also consider interviewing physicians who were not necessarily part of the EMR selection process, as we have expressed the concern that associate physicians may have differing perspectives on the procurement and adoption experience compared to decision makers. As a further series of studies, it would be interesting to conduct similar interviews with physicians in other Canadian provinces. Such studies would not be difficult or expensive to conduct and could offer insight into how other certification programs and reimbursement mechanisms affect adoption.

8.5.3 Physician office systems and the patient-provider relationship

The study that led to our third article [161] published in the International Journal of Telemedicine and Applications observed exam room layouts to determine how the location of computer systems supported or compromised physicians' interactions with their patients. We did not have the opportunity to observe patient-provider interaction directly as McGrath did [337]; however, we remain confident that conducting a similar study would offer insight into exactly how HIT affects the proxemics, kinesics, haptics and artifacts in the provider-patient dynamic. We originally planned to use nurses as observers in the exam room, but could not find the research budget or the time to support the work. There were obvious issues with ethics, although we did not attempt to design a study for which we could seek ethics approval. The purpose of this proposed study would be to observe patient-provider interactions in both computerized and non-computerized encounters to understand the effect that the computer has on the interaction. As above, confounding factors would need to be managed. Ideally, the study would consider observing many physicians' interactions with their patients. Physicians would have varying computer skills. Exam rooms would need to be selected to offer an ability to compare computer systems locations such that Angle A is less than, roughly equal to, and greater than 90 degrees. Observer training and video recording would help to build the reliability of the study.

8.5.4 Specialist referral

Primary care specialist referral remains a significant workflow issue for physician offices and patients. An opportunity exists to study the workflow and develop a HIT solution which standardizes the referral process for physician offices and specialists. There are software programs under development in Alberta which will address this; however, these programs only seek to record and distribute specialist preferences and contact information to physician offices and do not actually make a referral electronically. A unique opportunity exists to develop a ubiquitous solution that helps physician offices make referrals and helps specialist offices triage referrals.

8.5.5 The effect of Centralization on the adoption of HIT

The last area of interest that could warrant further exploration is that pertaining to centralization as a factor in HIT adoption. Alberta now has the rare opportunity to examine how centralization plays a role in HIT adoption. This PhD program was initiated when Alberta had 9 RHAs, many of which were playing an active role in the delivery of the provincial EHR. The jurisdiction amalgamated the RHAs to consolidate the information technology resources (along with other administrative functions) and to address some of the issues of coordinating independent organizations toward a provincial EHR. Now that the jurisdiction has eliminated those regions to create one single health region, the next and most immediate opportunity would be to conduct a review of health information systems adoption once the benefits of that consolidation have been realized.

8.6 List of Publications

The following tables summarize the peer reviewed papers, presentations and posters that were produced over the course of this graduate degree. Without diminishing the role of other contributors, the author of this thesis (a PhD student in the Engineering Management program) played the leading role in developing the research questions, study designs, research methodology as well as in the study execution, data gathering, analysis and report writing processes. Co-authors contributed to these studies by reviewing study designs, data analysis and manuscripts. The author acknowledges and thanks his co-investigators for their valuable contribution in these studies.

Article 1 [230], published in the conference proceedings of the Third IASTED International Conference on Telehealth, followed a simple, non-exhaustive review of peer reviewed and grey literature exploring the adoption of telehealth technology in pathology. This article concluded that asynchronous nature of SF technology can facilitate pathology consultation sooner than would be attainable through conventional methods, but that pathologist concerns regarding liability slowed the adoption of telepathology systems.

Article 2 [253], published in the International Journal of Medical Informatics, was a key contribution that formed the backbone of this dissertation. The study found that adopters of HIT had concerns about factors such as privacy, patient safety, provider-patient relations, staff anxiety, time factors, quality of care, finances, efficiency, and liability. Implementers can insulate their HIT projects 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 HIT deployment. The review showed that quality of care, patient safety and provider-patient relations were not, positively or negatively, affected by systems implementation.

Article 3 [161], published in the International Journal of Telemedicine and Applications, assessed the relevance of findings from the above literature review in the context of suburban, community Alberta primary care. The article concluded that socio-technical factors significantly affect physicians' implementation success. Moreover, physicians consistently complain about the lack of time available to investigate, procure and implement an EMR. The study recommended the investigation of other primary care settings, with different pay models, to determine if alternative remuneration and access to services plans might drive prudent behaviour during physician office system selection and implementation.

Article 4 [193], published in ElectronicHealthcare, recounts the experiences of the developing software operations management processes for the Alberta EHR. The article describes the process of implementing the operations management processes and the implications of this experience for adoption of HIT in primary care.

Article 5 [215], also published in ElectronicHealthcare, reviewed organizations which certify physician office systems to understand their role in the adoption of physician office systems. Certification organizations manage evaluation, procurement, financial, technical and software maintenance risk for primary care physicians. Certification organizations are advised to limit the number of approved systems to a range of 3 to 6 systems. Organizations are encouraged to tie physician reimbursement for systems adoption to usage or, better, to reporting quality of health outcomes. These timely recommendations are particularly insightful given the current landscape and changes put forward by policy makers of physician office system programs in western Canada.

Article 6 [78], accepted for publication in Canadian Family Physician, followed on the previous recommendations from Article 3. Specifically, this study was designed to reconsider the findings in Article 3 within the context of urban, hospital based and academic physicians. After studying physicians' procurement approaches under various payment models, the article concluded that no single remuneration approach supported adoption more than another. The study suggested that stronger physician professional networks used in information gathering, more complete training and in-house technical support may be more influential than remuneration in facilitating the adoption experience.

Article 7 [227] illustrates how telehealth combines with interdisciplinary teams to improve wait times for dermatology. Once again, the asynchronous nature of SF teledermatology technology improved timeliness of appointments. However, physicians also expressed concern about their liability if dermatologists do not assess the patient in person. Nevertheless, they will refer patients through teledermatology if they can be seen faster and if family physicians remain in control of the care process.

Articles 8, 9 and 10 [254, 255, 256] examine the efficacy of an online self-service appointment scheduling system in facilitating appointment scheduling in a small primary care office. The 3 part case study found that the system could substantially reduce the role of human resources in scheduling, was financially viable under certain cost circumstances and was able to facilitate appointment scheduling in a convenient manner for patients. Chi-square tests showed a dependent relationship between the likelihood to book appointments online and patients' computer aptitude and frequency of internet use. The study found that online self-service appointment scheduling was only suitable to patients with strong computer skills and extensive experience with the internet. Online appointment scheduling is only suitable for practices with predictable, repetitive scheduling workflow.

Table 8-1: List of peer-reviewed academic papers in archived journals and conference proceedings

	Authors	Title	Journal	Date
1	Ludwick D, Doucette J	The Effects of Telemedicine on the Pathology Process	IASTED Telehealth	June 2007
2	Ludwick D, Doucette J	Adopting EMRs in Primary Care: Lessons Learned from Health Information Systems Implementation Experience in Seven Countries	IJMI	April 2008
3	Ludwick D, Doucette J	Primary Care Physicians' Experience with Electronic Medical Records: Barriers to Implementation in a Fee-For-Service Environment	IJTA	October 2008
4	Ludwick D, Doucette J	The Implementation of Operational Processes for the Alberta EHR: Lessons for EMR Adoption in Primary Care	ElectronicHealthcare	March 2009
5	Ludwick D, Doucette J	A review of GP system certification programs in 7 countries and 5 Canadian provinces	ElectronicHealthcare	May 2009
6	Ludwick D, Manca D, Doucette J (accepted)	Primary Care Physicians' Experiences with Electronic Medical Records - Implementation experience in urban, hospital and academic family medicine	Canadian Family Practice	April 2009
7	Ludwick D, Lortie C, Samoil-Schelstraete C, Doucette J, Rao J (accepted)	Evaluation of a telehealth clinic as a means to facilitate dermatological consultation: A pilot project to assess the efficiency and experience of teledermatology used in a Primary Care Network	Journal of Cutaneous Medicine & Surgery	July 2009
8	Ludwick D, Doucette J (accepted)	Improve office efficiency by putting your patients to work: Case Study Part 1 of 3: Workflow implications of an online self-service appointment scheduling system in family practice.	ElectronicHealthcare	July 2009
9	Ludwick D, Doucette J (accepted)	Improve office efficiency by putting your patients to work: Case Study Part 2 of 3: The financial viability of an online self-service appointment scheduling system in family practice.	ElectronicHealthcare	July 2009
10	Ludwick D, Doucette J (accepted)	Improve office efficiency by putting your patients to work: Case Study Part 3 of 3: Patients' perspectives regarding online self-service appointment scheduling in family practice.	ElectronicHealthcare	July 2009

Table 8-2: List of presentations

Authors	Title	Conference	Date
Ludwick D, Ludwick C, Doucette	The Effects of Telemedicine on the Pathology Process	IASTED Telehealth	May 2007
Ludwick D	Case Study: The Alberta EHR - The Effect of Information and Computing Technology on Health Care: The Implications of Operational Processes	itSMF	June 2007
Ludwick D	Why aren't Primary Care Physicians adopting EMRs?	U of A Eng Mgmt Seminars	March 2008
Ludwick D, Doucette J	Case Study: The Alberta EHR - The Effect of Information and Computing Technology on Health Care: The Implications of Operational Processes in Government and Primary Care	eHealth 2008	May 2008
Ludwick D, Doucette J	Primary Care Physicians' Experiences with EMRs - Lessons for Primary Care Networks	Primary Care Initiative Forum	October 2008
Ludwick D	It's so easy to implement Electronic Medical Records - Not! Advice for vendors and policymakers	UVic Graduate Studies	October 2008
Ludwick D, Enns C, Relf M	Engaging Physicians: What's the deal?	Re-imagining Health Services	November 2008
Ludwick D	The effect of information and computing technology on healthcare	eHealth Focus Group, TRLabs	February 2009
Ludwick D, Doucette J	Online Self-Service In A Canadian Family Practice: Viability of an Online Self-Service Appointment Scheduling System	eHealth 2009	June 2009
Ludwick D, Lortie C, Samoil-Schelstraete C, Rao J	Teledermatology as a means to facilitate dermatological referral	84th Annual Canadian Dermatology Association Conference	July 2009
Ludwick D	Primary Care Reform in Alberta: The role of PCN's in Facilitating the Adoption of Health Information Technology	ANHIX Fall 2009 Conference	September 2009

Table 8-3: List of posters

Authors	Title	Conference	Date
Ludwick D, Young B, Greening S, White K, Weber N, McKim R.	Evaluation of a New PCN in Capital Health: A Pilot Study	Accelerating Primary Care 2008	February 2008
Ludwick	The Role of Change Management in the Deployment of Physician Office Systems	eHealth 2008	May 2008
Ludwick	Online Self-Service In A Canadian Family Practice: Implementing an Online Self-Service Appointment Scheduling System	Accelerating Primary Care 2009	February 2009
Ludwick D, Young B, Huey E	Clinical And Qualitative Evaluation Of A Centralized Chronic Disease Clinic In A Primary Care Network	Accelerating Primary Care 2009	February 2009
Cassidy R, Clark M, Drew L, Parks R, Ludwick D	Sherwood Park/Strathcona County Primary Care Network Mental Health Program: Operationalizing The "N" In PCN	Accelerating Primary Care 2009	February 2009
Ludwick D, Doucette J	Online Self-Service In A Canadian Family Practice: Viability of an Online Self-Service Appointment Scheduling System	eHealth 2009	May 2009

References

1. The Change Management Foundation. The Demand Management Think Tank. Backgrounder on Demand Management. January 23, 2002, Toronto, Ontario.
2. The Conference Board of Canada. Challenging Health Care System Sustainability – Understanding Health Systems Performance of Leading Countries. July 2004, (2004). Accessed at: http://www.health.alberta.ca/documents/Sustainable-system-CBC-2004.pdf . Accessed 2009 March 29.
3. Ostbye T, Yarnall KSH, Krasue KM, Pollak KI, Gradison M, Michener JL. Is there time for management of patients with chronic diseases in primary care? Ann Fam Med 2005;3:209-14.
4. The Change Management Foundation. Turning the Tide on Demand for Health Care. May 2005. Toronto, Ontario.
5. Canadian Institute of Health Information. Spending on health care to reach $5,170 per Canadian in 2008. November 13, 2008. Accessed at: http://secure.cihi.ca/cihiweb/dispPage.jsp?cw_page=media_13nov2008_e . Accessed 2009 January 28.
6. The Change Foundation. Rising Tide – Understanding Demand in Health Care. May 2005, Toronto, Ontario.
7. Husser A. Fewer doctors but no decline in health spending for Canada: OECD. Canwest News Service. Published: Friday, June 27, 2008. Accessed at: http://www.canada.com/topics/news/national/story.html?id=855a8425-3cac-4fcb-9c84-d146f019d490 . Accessed 2009 January 28.
8. Organization for Economic Co-operation and Development. OECD Health Data 2008. How Does Canada Compare? November 12, 2008. Accessed at: http://www.oecd.org/dataoecd/46/33/38979719.pdf . Accessed 2009 January 28.
9. Cassel C. The Future of Office Practice. Presented to the Institute for Healthcare Improvement 10th Annual International Summit on Redesigning the Clinical Office Practice, March 23, 2009, Vancouver, British Columbia, Canada.
10. Schoen C. Path to a High Performance US Health System: A 2020 Vision and the Policies to Pave the Way. Presentation to the 10th Annual International Summit on Redesigning the Clinical Office Practice, March 23, 2009, Vancouver, BC, Canada.
11. Starky S. The Obesity Epidemic in Canada. Library of Parliament. Parliamentary Information and Research Service. July 15, 2005. Accessed at: http://www.parl.gc.ca/information/library/PRBpubs/prb0511-e.htm . Accessed 2009 March 29.
12. Miller M, Taliento L. Battling childhood obesity in the US: An interview with Robert Wood Johnson's CEO. The McKinsey Quarterly. March 2009. Accessed at: http://www.mckinseyquarterly.com/Health_Care/Strategy_Analysis/Battling_childhood_obesity_in_the_US_An_interview_with_Robert_Wood_Johnson_CEO_2316 . Accessed 2009 March 14.
13. Sinnema J. Diabetes Looms For Kids. The Edmonton Journal, March 13, 2009. Accessed at: http://www.edmontonjournal.com/story_print.html?id=1384626&sponsor . Accessed 2009 March 14.
14. Statistics Canada. Canadian Community Health Survey, 2004. Accessed at: http://www.statcan.ca/english/research/82-620-MIE/2005001/tables.htm . Accessed 2009 March 14.
15. Statistics Canada. The Daily. Canadian Community Health Survey. Wednesday, June 18, 2008. Accessed at: http://www.statcan.gc.ca/daily-quotidien/080618/dq080618a-eng.htm . Accessed 2009 March 14.
16. Canadian Institutes of Health Research. Obesity Research in Canada. April 2, 2007. Accessed at: http://www.cihr-irsc.gc.ca/e/20406.html . Accessed 2009 March 14.
17. Canadian Institute for Health Information. Analytical Bulletin: 2004 National Physician Survey Response Rates and Comparability of Physician Demographic Distributions with those of the Physician Population. 2005:1. Accessed at: http://www.nationalphysiciansurvey.ca/nps/reports/PDF-e/CIHI_Analytical_Bulletin.pdf . Accessed 2009 March 29.
18. The College of Family Physicians of Canada, Canadian Medical Association, The Royal College of Physicians and Surgeons of Canada. (2007). 2007 National Physician Survey: National Demographics. Ottawa, Ontario. Accessed at: http://www.nationalphysiciansurvey.ca/nps/2007_Survey/Results/ENG/National/pdf/CANADA%20RESPONSE%20RATE%20Demographics.pdf . Accessed 2009 March 28.
19. Canadian Institute for Health Information. Canada's Health Care Providers. Ottawa, Ontario. November 20, 2001. Accessed at: http://secure.cihi.ca/cihiweb/products/hctenglish.pdf . Accessed 2009 July 25.
20. Canadian Labour and Business Center - Canadian Policy Research Networks (2005) Task Force Two: a Physician Human Resource Strategy for Canada: Canada's physician workforce: Occupational human resources - data assessment and trends analysis final report. Accessed at: http://www.caper.ca/docs/articles_interest/pdf_TF2%20Strategic%20Report%20-%20ENG%20FINAL.pdf . Accessed 2009 January 29.

21. The College of Family Physicians of Canada, Canadian Medical Association, The Royal College of Physicians and Surgeons of Canada. National Physician Survey 2007 Backgrounder. Ottawa, Ontario. Accessed at: http://www.cfpc.ca/local/files/Research/nps/NPS%202007%20Backgrounder%20%20-%20ENG%20FINAL.pdf . Accessed 2009 March 15.
22. Dumont J-C, Zurn P, Church J, Le Thi C. International Mobility of Health Professionals and Health Workforce Management in Canada: Myths and Realities. October 16, 2008. Accessed at: http://www.oecd.org/dataoecd/7/59/41590427.pdf . Accessed 2009 January 28.
23. Canadian Institute for Health Information. Health Care in Canada 2007. Ottawa, Ontario. Accessed at: http://secure.cihi.ca/cihiweb/products/hcic2007_e.pdf . Accessed 2009 March 28.
24. Sinnema J. Growing population outpaces doctors, specialists. Province misses targets to boost patient ratios. The Edmonton Journal, March 12, 2009. Accessed at: http://www.edmontonjournal.com/story_print.html?id=1380594&sponsor. Accessed 2009 March 12.
25. Kaiser Family Foundation. National Survey of Consumer Experiences With Health Plans. Menlo Park, Calif: Kaiser Family Foundation; June 2000. Accessed at: http://www.kff.org/insurance/loader.cfm?url=/commonspot/security/getfile.cfm&PageID=13510 . Accessed 2009 March 28.
26. Cunningham PJ, Clancy CM, Cohen JW, Wilets M. The use of hospital emergency departments for nonurgent health problems: a national perspective. Med Care Res Rev. 1995;52:453-474.
27. Sinnema J. Wait can average 27 hours for unlucky ER patients. The Edmonton Journal, March 14, 2009. Accessed at: http://www.edmontonjournal.com/story_print.html?id=1389466&sponsor= . Accessed 2009 March 15.
28. Murray M, Davies M, Boushon B. Panel Size. Answers to Physicians' Frequently Asked Questions. Family Practice Management, November/December 2007.
29. Siciliani L, Hurst J. Tackling excessive waiting times for elective surgery: a comparative analysis of policies in 12 OECD countries. Health Policy 72 (2005) 201-215.
30. Health Council of Canada. Wading through Wait Times. What Do Meaningful Reductions and Guarantees Mean? June 2007. Accessed at: http://www.healthcouncilcanada.ca/docs/rpts/2007/wait_times/hcc_wait-times-update_200706_FINAL%20ENGLISH.pdf . Accessed 2009 March 28.
31. Hall J. Province unveils electronic health data plan. The Toronto Star, March 30, 2009. Accessed at: http://www.thestar.com/printArticle/610773 . Accessed 2009 April 2.
32. European Observatory on Health Care Systems. Health care systems in eight countries: trends and challenges. April 2002. Accessed at: http://www.hm-treasury.gov.uk/d/observatory_report.pdf . Accessed 2009 March 28.
33. Strandberg-Larsen M, Nielsen MB, Vallgårda S, Krasnik A, Vrangbæk K and Mossialos E. Denmark: Health system review. Health Systems in Transition, 2007; 9(6): 1–164.
34. Healy J, Sharman E, Lokuge B. Australia: Health system review. Health Systems in Transition 2006; 8(5): 1–158.
35. Marchildon GP. Health Systems in Transition: Canada. Copenhagen, WHO Regional Office for Europe on behalf of the European Observatory on Health Systems and Policies, 2005. Accessed at: http://www.euro.who.int/document/e87954.pdf . Accessed 2009 March 28.
36. Health Council of Canada. Fixing the Foundation: An Update on Primary Health Care and Home Care Renewal in Canada. January 2008. Accessed at: http://www.healthcouncilcanada.ca/docs/rpts/2008/phc/HCC_PHC_Main_web_E.pdf . Accessed 27 January 2009.
37. Malcolm L. How general practice is funded in New Zealand. Medical Journal of Australia, Volume 181, Number 2, 19 July 2004.
38. Durán A, Lara JL, van Waveren M. Spain: Health system review. Health Systems in Transition. 2006; 8(4):1–208. Accessed at: http://www.euro.who.int/document/e89491.pdf . Accessed 2009 March 28.
39. European Observatory on Health Care Systems. Health Systems in Transition: United Kingdom. Copenhagen, 1999. Accessed at: http://www.euro.who.int/document/e68283.pdf . Accessed 2009 March 28.
40. Organization for Economic Cooperation and Development Health Project. Chapter 2: The Role of Private Health Insurance in Mixed Systems of Health Care Funding. Private Health Insurance in OECD Countries, p. 25-58. Accessed at: http://books.google.ca/books?id=oUM39nDp2s4C&pg=PA7&lpg=PA7&dq=OECD+Health+Project.++Chapter+2:++the+Role+of+Private+Health+Insurance+in+Mixed+Systems+of+Health+Care+Funding.++Private+Health+Insurance+in+OECD+Countries&source=bl&ots=j3mAI-vZ5V&sig=_0tk3ujwZSnUB-_6PD2OdzVyxIw&hl=en&ei=y3jPSbO3EeLlnQe0qrjPCQ&sa=X&oi=book_result&resnum=3&ct=result . Accessed 2009 March 29.
41. Glenngård AH, Hjalte F, Svensson M, Anell A, Bankauskaite V. Health Systems in Transition: Sweden. Copenhagen, WHO Regional Office for Europe on behalf of the European Observatory on Health Systems and Policies, 2005. Accessed at: http://www.euro.who.int/document/e88669.pdf . Accessed 2009 March 28.
42. Bindman AB, Forrest CB, Britt H, Crampton P, Majeed A. Diagnostic scope of and exposure to primary care physicians in Australia, New Zealand, and the United States: cross sectional analysis of results from three

national surveys. BMJ, doi:10.1136/bmj.39203.658970.55 (published 15 May 2007). Accessed at: http://www.bmj.com/cgi/rapidpdf/bmj.39203.658970.55v1 . Accessed 2009 February 28.
43. Chua K-P. Overview of the US Health Care System. February 10, 2006. Accessed at: http://www.amsa.org/uhc/HealthCareSystemOverview.pdf . Accessed 2009 February 7.
44. Kaiser Commission of Medicaid and The Uninsured. The Uninsured: A Primer. January 2006. Accessed at: http://www.kff.org/uninsured/upload/7451.pdf . Accessed 2009 February 7.
45. The Online NewsHour. The Uninsured in America. How We Are Insured. April 6, 2007. Accessed at: http://www.pbs.org/newshour/indepth_coverage/health/uninsured/howweareinsured.html . Accessed 2009 September 26.
46. Angell M. Privatizing health care is not the answer: lessons from the United States. Canadian Medical Association Journal, October, 21, 2008, 179(9).
47. Seshamani M, Lambrew JM, Antos JR. Financing the U.S. Health System: Issues and Options for Change. Bipartisan Policy Center. June 2008. Accessed at: http://www.bipartisanpolicy.org/ht/a/GetDocumentAction/i/6323 . Accessed 2009 April 6.
48. Auguste BG, Laboissière M, Mendonca LT. How health care costs contribute to income disparity in the United States. The McKinsey Quarterly, March 2009. Accessed at: http://www.mckinseyquarterly.com/PDFDownload.aspx?L2=7&L3=8&ar=2328&srid=17 . Accessed 2009 April 9.
49. Hacker JS. The cure for US health care is right in front of us; let's seize it now. McKinsey & Company. McKinsey What Matters. May 18, 2009. Accessible at: http://whatmatters.mckinseydigital.com/health_care/the-cure-for-us-health-care. Accessed 2009 June 1.
50. Herzlinger R. Can the United States provide health care for all? McKinsey & Company. McKinsey What Matters. May 18, 2009. Accessible at: http://whatmatters.mckinseydigital.com/health_care/can-the-united-states-provide-health-care-for-all . Accessed 2009 June 1.
51. Schoen C, Osborn R, Doty MM, et al. Toward higher-performance health systems: adults' health care experiences in seven countries, 2007. Health Aff (Millwood) 2007;26:w717-34.
52. DeNavas-Walt C, Proctor BD, Smith J. U.S. Census Bureau, Current Population Reports, P60-233, Income, Poverty, and Health Insurance Coverage in the United States: 2006, U.S. Government Printing Office, Washington, DC, 2007. Accessed at: http://www.census.gov/prod/2007pubs/p60-233.pdf . Accessed 2009 March 28.
53. Schoen C, Collins SR, Kriss JL, Doty MM. How many are underinsured? Trends Among US Adults, 2003 and 2007. Health Affairs Web Exclusive, June 10, 2008. Accessed at: http://www.cmwf.org/~/media/Files/Publications/In%20the%20Literature/2008/Jun/How%20Many%20Are%20Underinsured%20%20Trends%20Among%20U%20S%20%20Adults%20%202003%20and%202007/Schoen_howmanyareunderinsured_1144_itl%20pdf.pdf . Accessed 2009 March 29.
54. American College of Physicians. Achieving a high-performance health care system with universal access: what the United States can learn from other countries. Ann Intern Med 2008;148:1-21.
55. Anderson GF, Frogner BK. Health Spending in OECD Countries: Obtaining Value per Dollar. Health Affairs. November/December 2008 27(6):1718–27.
56. Centers for Medicare and Medicaid. Overview - Medicare. Accessed at: http://www.cms.hhs.gov/MedicareGenInfo/ . Accessed 2009 February 7.
57. Centers for Medicare and Medicaid. Overview - Medicaid. Accessed at: http://www.cms.hhs.gov/MedicaidGenInfo/ . Accessed 2009 February 7.
58. Centers for Medicare and Medicaid. Overview – SCHIP. Accessed at: http://www.cms.hhs.gov/LowCostHealthInsFamChild/ . Accessed 2009 February 7.
59. United States Department of Veterans Affairs. About VA Home. Accessed at: http://www.va.gov/about_va/ . Accessed 2009 February 7.
60. Forget EL, Deber R, Roos LL. Medical Savings Accounts: Will they reduce costs? Canadian Medical Association Journal, July 23, 2002; 167 (2).
61. European Observatory on Health Systems and Policies Series. Introduction: the question of decentralization. In: Saltman RB, Bankauskaite V, Vrangbaek K., eds. McGraw-Hill, Open University Press; 2007: 9-19.
62. Government of Alberta. One provincial board to govern Alberta's health system. May 15, 2008. Accessed at: http://www.alberta.ca/acn/200805/23523ED9498C0-0827-451C-E98A0B8430DC1879.html . Accessed 2009 March 15.
63. Protti D, Graham S. More Lessons to Be Learned About Primary Care Computing from Another Small Nation. ElectonicHealthcare, Vol. 2, No. 3.
64. Philippon D. Comparing Health Systems . University of Alberta, January 10, 2006. Accessed at: http://www.chcm.ubc.ca/documents/PhilliponMay24wIntro2007.ppt . Accessed 2009 April 2.
65. Carefx. The Changing Role of the Healthcare CIO: From Technologist to Strategist. 2009. Accessed at: http://www.carefx.com/xres/uploads/resource-center-documents/the_changing_role.pdf . Accessed 2009 February 22.

66. Health Canada. Primary Health Care Transition Fund, Accessed at: http://www.hc-sc.gc.ca/hcs-sss/prim/phctf-fassp/index_e.html Accessed 2009 January 26.
67. Primary Care Initiative, Alberta, What is Primary Care? Accessed at: http://www.albertapci.ca/AboutPCNs/PrimaryCare/Pages/default.aspx . Accessed 2009 March 29.
68. Gosden T, Forland F, Kristiansen IS, Sutton M, Leese B, Giuffrida A, Sergison M, Pedersen L. Capitation, salary, fee-for-service and mixed systems of payment: effects on the behaviour of primary care physicians. Cochrane Database of Systematic Reviews 2000, Issue 3. Art. No.: CD002215. DOI: 10.1002/14651858.CD002215.
69. Gottschalk A, Flocke SA. Time Spent in Face-to-Face Patient Care and Work Outside the Examination Room. Ann Fam Med. Vol. 3, No. 6, November/December 2005.
70. Mechanic D, McAlpine DD, Rosenthal M. Are patients' office visits with physicians getting shorter? N Engl J Med. 2001;344:198-204.
71. Crampton P, Jatrana S, Lay-Yee R, Davis P. Exposure to primary medical care in New Zealand: number and duration of general practitioner visits. Journal of the New Zealand Medical Association, 15-June-2007, Vol 120 No 1256. Accessed at: http://www.nzma.org.nz/journal/120-1256/2582/ . Accessed 2009 February 28.
72. Murray M. Reducing Waits and Delays in the Referral Process. Family Practice Management, March 2002. Accessed at: http://www.aafp.org/fpm/20020300/39redu.html . Accessed 2009 April 8.
73. Personal communications with Marilyn Kroon, Fees Consultant, Alberta Medical Association, February 3, 2009.
74. Alberta Health Care Insurance Plan. Alberta Schedule of Medical Benefits. 2008. Accessed at: http://www.health.alberta.ca/professionals/SOMB.html . Accessed 2009 February 7.
75. Thind A, Freeman T, Thorpe C. Family Physicians' Satisfaction with Current Practice: What is the Role of Their Interactions with Specialists? Healthcare Policy, Vol. 4, No. 3, 2009.
76. Alberta Bone & Joint Health Institute. Glossary of terms. Accessed at: http://www.albertaboneandjoint.com/glossary.asp . Accessed 2009 February 8.
77. Alberta Health and Wellness. Acute Care. Accessed at: http://www.health.alberta.ca/services/acute-care.html . Accessed 2009 February 8.
78. Ludwick DA, Manca D, Doucette J. Primary Care Physicians' Experiences with Electronic Medical Records Implementation experience in urban, hospital and academic family medicine. Canadian Family Physician. Accepted 2009 April 13.
79. World Health Organization. Chronic diseases. 2009. Accessed at: http://www.who.int/topics/chronic_diseases/en/ . Accessed 2009 February 28.
80. Alberta Health and Wellness. Home Care (Community-based Services). Accessed at: http://www.health.alberta.ca/services/home-care.html . Accessed 2009 February 8.
81. British Columbia Ministry of Health Services. Home and Community Care. Accessed at: http://www.health.gov.bc.ca/hcc/ . Accessed 2009 February 8.
82. Ontario Ministry of Health and Long Term Care. Seniors' Care: Overview of Care Programs. Accessed at: http://www.health.gov.on.ca/english/public/program/ltc/3_overview.html . Accessed 2009 February 8.
83. Alberta Health and Wellness. Long-term Care. Accessed at: http://www.health.alberta.ca/services/long-term-care.html . Accessed 2009 February 8.
84. Fooks C. Implementing Primary Care Reform in Canada: Barriers and Facilitators. Presented at Implementation of Primary Care Reform, School of Policy Studies, Queen's University, Kingston, ON. November 2003.
85. Romanow RJ. Building on values: the future of health care in Canada — final report. Saskatoon, Saskatchewan: Commission on the Future of Health Care in Canada, 2002. Available at: http://www.hc-sc.gc.ca/english/care/romanow/hcc0086.html . Accessed 2009 March 29.
86. Ontario Ministry of Health and Long Term Care. Guide to Interdisciplinary Team Roles and Responsibilities. July 4, 2005. Accessed at: http://www.health.gov.on.ca/transformation/fht/guides/fht_inter_team.pdf. Accessed 2009 January 27.
87. Canadian Nurses Association, Canadian Institute for Health Information. The Regulation and Supply of Nurse Practitioners in Canada: 2006 Update. 2006. Accessed at: http://www.cna-aiic.ca/CNA/documents/pdf/publications/Nurse_Practitioner_Workforce_Update_2006_e.pdf . Accessed 2009 March 29.
88. Ministry of Health and Long Term Care. Nurse Practitioner-Led Clinics. 2002. Accessed at: http://www.health.gov.on.ca/transformation/fht/np_clinics.html . Accessed 2009 February 28.
89. Pearson G. Evolution in the practice of pharmacy – not a revolution! Canadian Medical Association Journal. April 24, 2007, 176(9). Accessed at: http://www.cmaj.ca/cgi/reprint/176/9/1295 . Accessed 2009 February 7.
90. McMurtry A. Reinterpreting Interdisciplinary Health Teams from a Complexity Science Perspective. University of Alberta Health Sciences Journal, September 2007, Volume 4, Issue 1. Accessed at: http://www.uahsj.ualberta.ca/files/Issues/4-1/pdf/33.pdf . Accessed 2009 January 27.
91. Health Canada. Interprofessional Education for Collaborative Patient-Centred Practice. October 10, 2004. Accessed at: http://www.hc-sc.gc.ca/hcs-sss/hhr-rhs/strateg/interprof/index-eng.php . Accessed 2009 January 27.

92. ImpactBC. Integrated Health Networks. 2007. Accessed at: http://www.impactbc.ca/IHN . Accessed 2009 March 29.
93. OntarioMD. What is a Family Health Team? Accessed at: https://groups.ontariomd.ca/groups/node/261 . Accessed 2009 March 29.
94. Ministry of Health and Long Term Care. Family Health Teams and Nurse Practitioner-Led Clinics. 2002. Accessed at: http://www.health.gov.on.ca/transformation/fht/fht_mn.html . Accessed 2009 February 28.
95. Kates N. Primary Care Transformation and Quality Improvement in Ontario. Presentation to the 10th Annual International Summit on Redesigning the Clinical Office Practice, March 24, 2009, Vancouver, BC, Canada.
96. New Zealand Ministry of Health. Primary Health Care, Primary Healthcare Organisations (PHOs). Accessed at: http://www.moh.govt.nz/moh.nsf/indexmh/phcs-pho . Accessed 2009 March 29.
97. National Health System. NHS Choices. About the NHS. Accessed at: http://www.nhs.uk/aboutnhs/howtheNHSworks/authoritiesandtrusts/Pages/Authoritiesandtrusts.aspx#q05 . Accessed 2009 February 28.
98. Walshe K, Smith J, Dixon J, Edwards N, Hunter DJ, Mays N, Normand C, Robinson R. Primary care trusts. Premature reorganisation, with mergers, may be harmful. BMJ. Vol. 329, 16 October 2004.
99. Kidd MR, Watts IT, Saltman DC. Primary health care reform: equity is the key. MJA, Vol. 189, No. 4, 18 August 2008. Accessed at: http://www.mja.com.au/public/issues/189_04_180808/kid10646_fm.pdf . Accessed 2009 February 28.
100. Russell LM. A Primary Care Reform Agenda for Australia. July 29, 2008. Accessed at: http://www.menzieshealthpolicy.edu.au/MCHP_V3/site/other%20tops/NewReform%20of%20Primary%20Healthcare.doc . Accessed 2009 February 28.
101. Douglas K. New Models of Primary Care – The Evidence. National Health Care Reform Conference, Sydney, March 2008. Accessed at: http://www.anu.edu.au/aphcri/Presentations/national%20health%20care%20reform%20conference.ppt . Accessed 2009 February 28.
102. Edmonton Oliver PCN. Programs. Accessed at: http://edmontonoliverpcn.com/programs.html . Accessed 2009 February 28.
103. Alberta Health Services Calgary Health Region. South Calgary Primary Care Network. Accessed at: http://www.calgaryhealthregion.ca/pcp/121_southpcnhome.htm . Accessed 2009 February 28.
104. Alberta Primary Care Initiative. Guidelines to PCN Funding. 2008. Accessed at: http://www.albertapci.ca/DevelopingPCN/BusinessPlanDevt/ServicePlanning/Pages/GuidelinestoPCNFunding.aspx . Accessed 2009 February 28.
105. Bates DW, Ebell M, Gotlieb E, Zapp J. Mullins HC. A Proposal for Electronic Medical Records in U.S. Primary Care. J Am Med Inform Assoc. 2003;10:1–10. DOI 10.1197/jamia.M1097.
106. Martin C, Hogg W. How family physicians are funded in Canada. Medical Journal of Australia. Volume 181, Number 2, 19 July 2004.
107. Program Evaluation and Economic Konsulting. Quality Based Incentive Payments: International Experiences, Lessons for Canada. Accessed at: http://www.gov.mb.ca/health/phc/pin/docs/phase1.pdf . Accessed 2009 January 25.
108. Australian Government. Medicare Australia. Medicare Benefits Schedule (MBS). 18 February 2009. Accessed at: http://www.medicareaustralia.gov.au/provider/medicare/mbs.jsp . Accessed 2009 March 1.
109. College of Family Physicians of Canada. Remuneration Methods – Salary. Accessed at: http://toolkit.cfpc.ca/en/remuneration/salary.php . Accessed 2009 March 20.
110. College of Family Physicians of Canada. Remuneration Methods – FFS. Accessed at: http://toolkit.cfpc.ca/en/remuneration/fee-for-service.php . Accessed 2009 March 20.
111. Personal communication with Dr. E.J. Cahill, President, Sherwood Park Primary Care Network. August 20, 2008.
112. Personal conversation with Dr. Rob Shute. Grey Nuns Family Medicine Centre. November 21, 2008.
113. Alberta Medical Association. Alternative Relationship Plans. October 23, 2008. Accessed at: http://www.albertadoctors.org/bcm/ama/ama-website.nsf/AllDoc/80C703BC6415D45D87256DE3005E7BF6?OpenDocument . Accessed 2009 March 29.
114. College of Family Physicians of Canada. Alternative Payment or Funding Plans. 2007. Accessed at: http://toolkit.cfpc.ca/en/remuneration/alternative-payment-funding-plans.php . Accessed 2009 March 29.
115. College of Family Physicians of Canada. Remuneration Methods – Capitation. Accessed at: http://toolkit.cfpc.ca/en/remuneration/capitation.php . Accessed 2009 March 20.
116. Leamington & Area Family Health Team. How to Become a Patient of the Leamington & Area Family Health Team. Accessed at: http://www.mindboxcreativegroup.com/client_testing/lfht_ca/index.html . Accessed 2009 January 25.
117. Tilbury District Family Health Team. Patient Enrolment Information. 2008. Accessed at: http://www.tdfht.ca/patients.htm . Accessed on 1 March 2009.
118. New Vision Family Health Team. Frequently Asked Questions. Accessed at: http://newvisionhealth.ca/content/info_/faq.php . Accessed 2009 March 1.

119. Atlas SJ, Chang Y, Lasko TA, Chueh HC, Grant RW, Barry MJ. Is This ''My'' Patient? Development and Validation of a Predictive Model to Link Patients to Primary Care Providers. J Gen Intern Med 2006; 21:973–978, DOI: 10.1111/j.1525-1497.2006.00509.x
120. Alberta Health and Wellness. Semi-annual Report to Sherwood Park – Strathcona County PCN. October 2008.
121. Murray M, Davies M, Boushon B. Panel Size. How Many Patients Can One Doctor Manage? Family Practice Management, April 2007.
122. McAvoy B, Coster G. General practice and the New Zealand health reforms – lessons for Australia? Australia and New Zealand Health Policy 2005, 2:26.
123. College of Family Physicians of Canada. Remuneration Methods – Sessional. Accessed at: http://toolkit.cfpc.ca/en/remuneration/sessional-payment.php . Accessed 2009 March 20.
124. Wysong P. Cutting the cheque in different ways. MDPulse 2005. Accessed at: http://www.cma.ca/Multimedia/CMA/Content_Images/Inside_cma/WhatWePublish/LeadershipSeries/English/6_Cutting.pdf . Accessed 2009 March 28.
125. National Committee for Quality Health Care. CEO Survival Guide – Pay For Performance 2006 Edition. 2006. Accessed at: http://www.leapfroggroup.org/media/file/HospitalCEOGuidetoP4P.pdf . Accessed 2009 January 25.
126. Mays N. Use of targets to Improve Health System Performance: English NHS Experience and Implications for New Zealand. July 2006. Accessed at: http://www.treasury.govt.nz/publications/research-policy/wp/2006/06-06/twp06-06.pdf . Accessed 2009 January 27.
127. Manitoba Health. What is Quality Based Incentive Funding? 2008. Accessed at: http://www.gov.mb.ca/health/phc/pin/qbif.html . Accessed 2009 January 25.
128. Alberta Medical Association. The President's Letter. February 27, 2009. Accessed at: http://www.albertadoctors.org/bcm/ama/ama-website.nsf/AllDoc/D36913E2C74EE48987257569007AD99D/$File/preslet_feb_27_09.pdf . Accessed 2009 March 1.
129. L.T. Kohn, J.M. Corrigan, and M.S. Donaldson, eds., To Err Is Human: Building a Safer Health System (Washington: National Academies Press, 1999).
130. Endsley S, Baker G, Kershner BA, Curtin K. What Family Physicians Need to Know About Pay for Performance. Family Practice Management, July/August 2006.
131. Wikipedia. Quality and Outcomes Framework. Accessed at: http://en.wikipedia.org/wiki/Quality_and_Outcomes_Framework . Accessed 2009 January 25.
132. Ashworth M, Jones RH. Pay for performance systems in general practice: experience in the United Kingdom. Medical Journal of Australia, Volume 189, Number 2, 21 July 2008.
133. Conference Board of Canada. The U.K. Way, Spending and Measuring in the National Health Service. Lessons for Canada. June 2007. Accessed at: http://www.conferenceboard.ca/Libraries/NETWORK_PUBLIC/The%20UK%20Way%20-%20June%202007.sflb . Accessed 2009 March 29.
134. Personal conversation with Roger Girard, Executive Director, Manitoba eHealth. October 3, 2008.
135. Wilson R. Primary Care Renewal in Ontario—Focus on Remuneration. November 2006. Accessed at: http://toolkit.cfpc.ca/en/remuneration/documents/CFPC.PCForum.RuthWilson-Remuneration.ppt . Accessed 2009 January 25.
136. Alberta Medical Association. Remarks to RF – Dr. N.W. Grisdale. December 13, 2008. Accessed at: http://www.albertadoctors.org/bcm/ama/ama-website.nsf/AllDoc/C6FA5389D4D19EB587257522005D8E29?OpenDocument . Accessed 2009 March 15.
137. Alberta Medical Association. The President's Letter. December 13, 2008. Accessed at: http://www.albertadoctors.org/bcm/ama/ama-website.nsf/AllDoc/7B1971139A47C9828725751D00616D82/$File/preslet_dec13_08_y.pdf . Accessed 2009 March 15.
138. Alberta Health and Wellness, Alberta Medical Association and Alberta Health Services. Letter of Understanding Amending Financial Agreement April 1, 2008 – March 31, 2011. November 13, 2008.
139. Ontario Ministry of Health and Long Term Care. Guide to Health Promotion and Disease Prevention. January 16, 2006. Accessed at: http://www.health.gov.on.ca/transformation/fht/guides/fht_health_promotion2.pdf . Accessed 2009 January 27.
140. Doebbeling BN, Chou AF, Tierney WM. Priorities and Strategies for the Implementation of Integrated Informatics and Communications Technology to Improve Evidence-Based Practice. J Gen Intern Med 2006; 21:S50–57.
141. Health Council of Canada. Health Care Renewal in Canada: Accelerating Change. January 2005. Accessed at: http://www.healthcouncilcanada.ca/docs/rpts/2005/Accelerating_Change_HCC_2005.pdf . Accessed 2009 January 27.
142. National Information Center on Health Services Research and Health Care Technology. HTA101: Glossary. Accessed at: http://pages.citebite.com/h2w1i8fbcow . Accessed 2009 February 16.

143. Tang P. Key Capabilities of an Electronic Health Record System. Letter Report. Institute of Medicine Committee on Data Standards for Patient Safety. Board on Health Care Services. Washington D.C.: National Academies Press. July 31, 2003. Accessed at: http://www.nap.edu/catalog.php?record_id=10781 . Accessed 2009 March 28.
144. Raab S, Grzybicki D, Janosky J, Zarbo R, Meier F, Jensen C, Geyer S. Clinical Impact and Frequency of Anatomic Pathology Errors in Cancer Diagnoses. Cancer. November 15, 2005, Volume 104, Number 10.
145. Davies P, Lay-Yee R, Scott A, Briant R, Schug S. Acknowledgement of 'no fault' medical injury: review of patients' hospital records in New Zealand. BMJ 2003;326:79-80.
146. Wilson RM, Runciman WB, Gibbard RW, Harrison BT, Newby L, Hamilton JD. The quality of Australian health care study. Med J Aust 1995;163:458-71.
147. Baker G, Norton P, Flintoft V, Blais R, Brown A, Cox J et al. The Canadian Adverse Events Study: the incidence of adverse events among hospital patients in Canada. CMAJ 2004;170(11):1678-86.
148. Lysecki S. Calgary's e-health glitch: What went wrong? July 21, 2005. Accessed at: http://www.itbusiness.ca/it/client/en/Home/News.asp?id=1993 . Accessed 2009 January 29.
149. Sinnema J. Glitch puts patients in danger. January 28, 2009. Edmonton Journal. Accessed at: http://www.edmontonjournal.com/Health/Glitch+puts+patients+danger/1225962/story.html . Accessed 2009 January 29.
150. Han YY, Carcillo JA, Venkataraman ST, Clark RSB , Watson RS, Nguyen TC, Bayir H, Orr RA. Unexpected Increased Mortality After Implementation of a Commercially Sold Computerized Physician Order Entry System. Pediatrics. 2005;116;1506-1512.
151. Koppel R, Metlay JP, Cohen A, Abaluck B, Localio AR, Kimmel SE, Strom BL. Role of Computerized Physician Order Entry in Facilitating Medical Errors. JAMA, Vol. 293, No. 10, pp1197-1202.
152. Zarbo R, Meier F, Raab S. Error Detection in Anatomic Pathology. Arch Pathol Lab Med—Vol 129, No. 10, October 2005.
153. Jacobs S, O'Beirne M, Palacios Derflingher L, Vlach L, Rosser W, Drummond N. Errors and adverse events in family medicine. Can Fam Physician 2007;53:270-276.
154. Marilyn J. Field and Kathleen N. Lohr, Editors; Committee to Advise the Public Health Service on Clinical Practice Guidelines, Institute of Medicine. National Academy Press, Washington, DC, 1990.
155. National Heart, Lung and Blood Institute. About Clinical Practice Guidelines. Accessed at: http://www.nhlbi.nih.gov/guidelines/about.htm . Accessed 2009 March 5.
156. Dunn BE, Almagro UA, Choi H, Recla DL, Weinstein RS. Use of telepathology for routine surgical pathology review in a test bed in the Department of Veterans Affairs. Telemedicine Journal. 1997 Spring;3(1): 1-10.
157. Howantiz PJ. Errors in Laboratory Medicine: Practical Lessons to Improve Patient Safety. Archives of Pathology and Laboratory Medicine. 2005; 129: 1252-1261.
158. Safrin RE, Bark CJ. Surgical pathology signout. Routine review of every case by a second pathologist. American Journal of Surgical Pathology. 1993;17: 1190–1192.
159. Ramsay AD, Gallagher PJ. Local audit of surgical pathology. 18 month's experience of peer-review-based quality assurance in an English teaching hospital. American Journal of Surgical Pathology. 1992;16: 476–482.
160. Garg AX, Adhikari NKJ, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J. Sam J, Haynes RB. Effects of Computerized Clinical Decision Support Systems on Practitioner Performance and Patient Outcomes. JAMA. 2005;293(10):223-1238.
161. Ludwick DA, Doucette J. Primary Care Physicians' Experience with Electronic Medical Records: Barriers to Implementation in a Fee-for-Service Environment. Int J Telemed Appl 2009;2009:853524. Epub 2008 Dec 4, 2008. Accessed at: http://www.hindawi.com/GetArticle.aspx?doi=10.1155/2009/853524&e=ref . Accessed 2009 March 29.
162. National Committee for Quality Assurance. Accreditation. 2009. Accessed at: http://www.ncqa.org/tabid/66/Default.aspx . Accessed 2009 March 1.
163. The Leapfrog Group. The Leapfrog Group Fact Sheet. Accessed at: http://www.leapfroggroup.org/about_us/leapfrog-factsheet . Accessed 2009 March 28.
164. Classen DC, Avery AJ, Bates DW. Evaluation and Certification of Computerized Provider Order Entry Systems. J Am Med Inform Assoc. 2007;14:48 –55. DOI 10.1197/jamia.M2248
165. The Leapfrog Group. The Leapfrog Hospital Survey. v5.0, March 2008. Accessed at: https://leapfrog.medstat.com/pdf/Background.pdf . Accessed 2009 March 29.
166. Kilbridge PM, Welebob EM, Classen DC. Development of the Leapfrog methodology for evaluating hospital implemented inpatient computerized physician order entry. Qual. Saf. Health Care 2006;15;81-84 doi:10.1136/qshc.2005.014969
167. Health Canada. EMR Toolkit: Implementing electronic medical records in primary health care settings. 2007. Accessed at: http://www.emrtoolkit.ca/ Accessed 2008 January 20.
168. Canadian Broadcasting Corporation. Health records. Canada lags in electronic medical records. January 28, 2008. Accessed at: http://www.cbc.ca/news/background/healthcare/records.html . Accessed 2009 March 29.

169. Bossen C. Test the artefact—Develop the organization The implementation of an electronic medication plan. International Journal of Medical Informatics. 76 (2007), 13–21.
170. Gamble B. Using IT to make primary care reform work for you. Future Practice. 11 April 2006. Accessed at: http://www.cma.ca/multimedia/CMA/Content_Images/Inside_cma/Future_Practice/English/2006/April/using_IT.pdf . Accessed 2009 March 29.
171. Schuster DM, Hall SE, Couse CB, Swayngim DS, Kohatsu KY. Involving Users in the Implementation of an Imaging Order Entry System. Journal of the American Medical Informatics Association. Vol. 10 No. 4, Jul / Aug 2003.
172. Personal conversations with Sherwood Park – Strathcona County PCN primary care physicians. January to March 2009.
173. Sittig DF. Dealing with the Unintended Consequences of Computer-Based Provider Order Entry. AMIA Annual Symposium Proceedings 1174.
174. Campbell EM, Sittig DF, Ash JS, Guappone KP, Dykstra RH. Types of Unintended Consequences Related to Computerized Provider Order Entry. Journal of the American Medical Informatics Association 13: 547-56.
175. Murray M, Berwick D. Advanced Access: Reducing Waiting and Delays in Primary Care. JAMA, February 26, 2003, Vol. 289, No. 8.
176. Murray M, Tantau C. Same-Day Appointments: Exploding the Access Paradigm. Family Practice Management, September 2000.
177. O'Hare C, Corlett J. The Outcomes of Open-Access Scheduling. Family Practice Management, February 2004.
178. Christakis DA, Wright JA, Zimmerman FJ, Bassett AL, Connell FA. Continuity of care is associated with well-coordinated care. Ambul Pediatr. 2003 Mar-Apr;3(2):82-6.
179. Murray M, Bodenheimer, Rittenhouse D, Grumbach K. Improving Timely Access to Primary Care. JAMA, February 26, 2003, Vol. 289, No. 8.
180. Stausberg J, Koch D, Ingenerf J, Betzler M. Comparing Paper-based with Electronic Patient Records: Lessons Learned during a Study on Diagnosis and Procedure Codes. Journal of the American Medical Informatics Association Volume 10 Number 5 Sep / Oct 2003.
181. Canadian Business. Alberta Medical Association: Alberta Physicians Oppose Bill 52. February 4, 2009. Accessed at: http://www.canadianbusiness.com/markets/marketwire/article.jsp?content=20090204_113506_0_ccn_ccn . Accessed 2009 February 7.
182. Lyons R, Payne C, McCabe M, Fielder C. Legibility of doctors' handwriting: quantitative comparative study. BMJ 1998;317;863-864.
183. Morrissey, J. A Day in the Life of a Medical Record. The National Alliance for Health Information Technology. 2006. Accessed at: http://www.providersedge.com/ehdocs/ehr_articles/A_Day_in_the_Life_of_a_Medical_Record.pdf . Accessed 2009 March 29.
184. Canadian Medical Association Journal. Have paper records passed their expiry date? Editorial. September 27, 2005; 173 (7).
185. Roukema J, Renske KL, Bleeker SE, van Ginneken AM, vander Lei J, Moll HA. Paper Versus Computer: Feasibility of an Electronic Medical Record in General Pediatrics. Pediatrics. Vol. 117, No. 1 January 2006.
186. Schabetsberger T, Ammenwerth E, Andreatta S, Gratl G, Haux R, Lechleitner G, Schindelwig K, Stark C, Vogl R, Wilhelmy I, Wozak F. From a paper-based transmission of discharge summaries to electronic communication in health care regions. International Journal of Medical Informatics (2006) 75, 209—215.
187. Health Canada. Canada's Health Care System (Medicare). October 1, 2004. Accessed at: http://www.hc-sc.gc.ca/hcs-sss/medi-assur/index-eng.php . Accessed 2009 February 28.
188. Wikipedia. Electronic medical record (2007). Accessed at: http://en.wikipedia.org/wiki/Electronic_medical_record . Accessed 2009 March 29.
189. Physician Office System Program. Testimonials. 2007. Accessed at: http://www.posp.ab.ca/testimonials/ Accessed 2009 March 29.
190. Rehm S, Kraft S. Electronic Medical Records: The FPM Vendor Survey. Family Practice Management. January 2001. Accessed at: http://www.aafp.org/fpm/20010100/45elec.pdf . Accessed 2009 March 28.
191. Wikipedia. Practice management (2007). Accessed at: http://en.wikipedia.org/wiki/Practice_management Accessed 2009 March 29.
192. College of Family Physicians of Canada. Electronic Medical Records. 2007. Accessed at: http://toolkit.cfpc.ca/en/information-technology/electronic-medical-record.php Accessed 2009 March 29.
193. Ludwick DA, Doucette J. The Implementation of Operational Processes for the Alberta EHR: Lessons for EMR Adoption in Primary Care, ElectronicHealthcare. Vol. 7, No. 4, 2009.
194. Physician Information Technology Office. Application Service Provider (ASP) Information Sheet. Ver 1.2, May 27, 20098. Accessed at: http://www.pito.bc.ca/Documents/PITO%20ASP%20Info%20Sheet%20v1.2%2008-05-27.pdf . Accessed 2009 February 4.
195. Brookstone A. ASP vs. Client-Server EMR. Which is best? CanadianEMR. Accessed at: http://emruser.typepad.com/canadianemr/2004/06/is_asp_vs_clien.html . Accessed 2009 February 4.

196. Folker G. eHealth Tools. Patient-centric care drives technology purchases. Summit. January/February 2008. Accessed at: http://summitmagazine.com/Articles_Columns/PDF_Documents/w11_1_01.pdf . Accessed 2009 February 4.
197. MR Experts. Electronic Medical Records: Client/Server or ASP? 2008. Accessed at: http://www.emrexperts.com/articles/client-server-asp-emr.php . Accessed 2009 February 4.
198. Canadian Healthcare Technology. ASP solution offers the ability to access the EMR anywhere, anytime. Canadian Healthcare Technology, April 2007. Accessed at: http://www.xwave.com/files/credentials/Canadian_Healthcare_Technology_07.pdf . Accessed 2009 February 4.
199. Boaden R, Joyce P. Developing the electronic health record: what about patient safety? Health Services Management Research. 19:94-104
200. Kalra D. Electronic Health Record Standards. IMIA Yearbook of Medical Informatics 2006. Accessed at: http://eprints.ucl.ac.uk/2292/1/schattauer_30_2006_1_136.pdf . Accessed 2009 February 4.
201. Canada Health Infoway. EHRS Blueprint: An interoperable EHR framework (2006). Accessed at: http://knowledge.infoway-inforoute.ca/EHRSRA/doc/EHRS-Blueprint.pdf . Accessed 2009 March 28.
202. Ferris N. A matter of semantics. Government Health IT. Accessed at: http://www.govhealthit.com/print/2_7/features/91416-1.html . Accessed 2009 March 29.
203. Department of Health UK. Delivering 21st Century IT Support for the NHS - National Strategic Programme. The Stationery Office; 2002. Accessed at: http://www.medgraphics.cam.ac.uk/Downloads/NHS_0007.PDF . Accessed 2009 March 28.
204. May L. The National E-Health Transition Authority (NEHTA). Health Information Management Vol. 34 (1) 2005. Accessed at: http://www.mja.com.au/public/journal/34_1_2005/pdf/may.pdf . Accessed 2009 March 28.
205. United States Department of Health and Human Services. Harnessing information technology to improve health care. Fact Sheet 6th May 2004. Accessed at: http://www.hhs.gov/news/press/2004pres/20040427a.html . Accessed 2009 March 28.
206. Jha AK, Doolan D, Grandt D, Scott T, Bates DW. The use of health information technology in seven nations. Int. J. Med. Inform. (2008), doi:10.1016/j.ijmedinf.2008.06.007.
207. HealthConnect SA. High Level "Connectivity" Options Paper. Executive Summary. September 21, 2006. Accessed at: http://www.healthconnectsa.org.au/Portals/0/HealthConnect%20SA%20Connectivity%20Paper%20Summary.pdf . Accessed 2009 March 29.
208. European Commission. eHealth priorities and strategies in European countries. eHealth ERA report - March 2007. Belgium. Accessed at: http://www.ehealth-era.org/documents/2007ehealth-era-countries.pdf . Accessed 2009 March 29.
209. Moore J. Can HIEs be certified? Government Health IT. July 30, 2008. Accessed at: http://www.govhealthit.com/print/4_19/rhio_report/350482-1.html. Accessed 2009 March 28.
210. National E-Health Transition Authority. NEHTA Interoperability Framework v2.0 August 17, 2007, Sydney, NSW, Australia. Accessed at: http://www.nehta.gov.au . Accessed 2009 March 28.
211. OpenClinical. Interoperability. January 2007. Accessed at: http://www.openclinical.org/interoperability.html . Accessed 2009 March 28.
212. Benson T. Why general practitioners use computers and hospital doctors do not—Part 2: scalability. BMJ Vol. 325, November 2002
213. Aguilar A. Semantic Interoperability in the Context of eHealth. Accessed at: http://www.antonio-aguilar.com/files/papers/ehealth_aguilar.pdf . Accessed 2009 March 29.
214. Sawatsky E. Certification and Conformance Approaches for Canada's EHR. Presentation to eHealth 2008. Portoroz, Slovenia, May 2008 Accessed at: http://www.eurorec.org/news.cfm?actief=news&show=upcoming&ID=166 . Accessed 2008 September 5.
215. Ludwick DA, Doucette J. A review of GP system certification programs in 7 countries and 5 Canadian provinces. ElectronicHealthcare. Vol. 8, No. 1.
216. Canada Health Infoway. EHR Progress Map. Accessed at: http://www.infoway.ca/lang-en/about-ehr/ehr-progress-map . Accessed 2009 September 24.
217. Goldstein J. Stimulus Funds for E-records Augur Big Windfall for Small Health Firms. The Wall Street Journal. March 24, 2009. Accessed at: http://online.wsj.com/article/SB123785277722019609.html . Accessed 2009 March 29.
218. SK&A Information Services. SK&A Reveals EMR Adoption Rates for Physician Offices. Accessed at: http://www.skainfo.com/press_releases.php?article=74 . Accessed 2009 April 15.
219. Alberta Medical Association. AMA President's Letter. February 4, 2009. Accessed at: http://www.albertadoctors.org/bcm/ama/ama-website.nsf/AllDoc/564329D606FA6D68872575520078A236/$File/preslet_feb_4_09.pdf . Accessed 2009 March 21.

220. Office of the Information and Privacy Commissioner. Commissioner concerned by amendments to Health Information Act. December 1, 2008. Accessed at: http://www.alberta.ca/home/NewsFrame.cfm?ReleaseID=/acn/200812/24863F3E7A76A-EDD9-5E76-23FDD5D2CB09C4B4.html . Accessed 2009 February 7.
221. Alberta Medical Association. AMA President's Letter. May 15, 2009. Accessible at: http://www.albertadoctors.org/bcm/ama/ama-website.nsf/AllDoc/D5965ACD5CA3C0E1872575B70053FBED/$File/Preslet_may15_09.pdf . Accessed 2009 June 1.
222. Perednia D, Allen A. Telemedicine technology and clinical applications. Journal of the American Medical Association. Vol. 273, No. 6, pp. 483-488, 8 February 1995.
223. Craig J, Patterson V. Introduction to the practice of telemedicine. Journal of Telemedicine and Telecare 2005; 11: 3–9.
224. Allen M, Sargeant J, MacDougall E, Proctor-Simms M. Videoconferencing for continuing medical education: from pilot project to sustained programme. Journal of Telemedicine and Telecare 2002; 8: 131–137.
225. Allen M, Sargeant J, MacDougall E, O'Brien B. Evaluation of videoconferenced grand rounds. Journal of Telemedicine and Telecare 2002; 8: 210 216.
226. Cornish P, Church E, Callanan T, Bethune C, Robbins C, Miller R. Rural Interdisciplinary Mental Health Team Building via Satellite: A Demonstration Project. Telemedicine Journal and e-Health. Vol. 9, No. 1, 2003.
227. Ludwick D, Lortie C, Doucette J, Rao, J, Samoil – Schelstraete C. Evaluation of a telehealth clinic as a means to facilitate dermatological consultation: A pilot project to assess the efficiency and experience of teledermatology used in a Primary Care Network. Journal of Cutaneous Medicine & Surgery. Accepted July 2009.
228. Mairinger t, TaroNetzer T, Schoner W, Gschwendtner A. Pathologists' attitudes to implementing Telepathology. Journal of Telemedicine and Telecare. Vol. 4, No. 1, pp. 41-46, March 1998.
229. Brown N. Information on telemedicine. Journal of Telemedicine and Telecare 2005; 11: 117–126
230. Ludwick D, Ludwick C, Doucette J. The Effects of Telemedicine on the Pathology Process. Conference Proceedings of The Third IASTED International Conference on Telehealth.
231. Ontario Telemedicine Network. What We Do. 2008. Accessed at: http://www.otn.ca/en/otn/what-we-do/ . Accessed 2009 April 10.
232. University of Queensland Centre for Online Health. Health-e-Screen 4 Kids. March 13, 2009. Accessed at: http://www.uq.edu.au/coh/index.html?page=99096&pid=0 . Accessed 2009 April 10.
233. Endsley, S., Kibbe, D. C., Linares, A., Colorafi, K. An Introduction to Personal Health Records. Family Practice Management, Vol. 13, No. 5. Accessed at: http://www.aafp.org/fpm/20060500/57anin.html . Accessed 2009 February 7.
234. Yung A, Li YY. A Literature Review of Developments in Health Information Banks. ElectronicHealthcare, Vol. 7, No. 4, 2009.
235. Canadian Medical Association. Mydoctor.ca Health Portal. Accessed at: https://www.mydoctor.ca . Accessed 2009 April 2.
236. Lohr S. Microsoft Rolls Out Personal health Records. New York Times, October 4, 2007. Accessed at: http://www.nytimes.com/2007/10/04/technology/04nd-soft.html Accessed 2009 March 29.
237. Lohr S. Google Offers Personal Health Records on the Web. New York Times, May 20, 2008. Accessed at: http://www.nytimes.com/2008/05/20/technology/20google.html?fta=y . Accessed 2009 March 29.
238. Department of Health and Human Resources, Centers for Medicare and Medicaid Services, Personal Health Records, September 25, 2008, Accessed at: http://www.cms.hhs.gov/perhealthrecords/ . Accessed 2009 March 29.
239. Press A. Medical Practice 101 - How Online Patient Scheduling And Automated Appointment Reminders Can Help Doctors? Accessed at: http://www.content4reprint.com/business/business-opportunities/medical-practice-101-how-online-patient-scheduling-and-automated-appointment-reminders-can-help-doctors.htm . Accessed 2009 March 29.
240. Huff C. DIAGNOSIS: Doctor's Office Rebellion. PRESCRIPTION: Put the patient first. American Way, July 1, 2008. Accessed at: http://www.americanwaymag.com/tabid/2855/tabidext/3985/default.aspx . Accessed 2009 March 29.
241. RedOrbit News. Two Medical Practices Select Galvanon's Self-Service Solutions to Improve Efficiency and Enhance the Patient Experience, October 31, 2007. Accessed at: http://redorbit.com/news/health/1125425/two_medical_practices_select_galvanons_selfservice_solutions_to_improve_efficiency/index.html . Accessed 2009 March 29.
242. Painter K. Micro practice makes perfect? USAToday, May 21, 2006, Accessed at: http://www.usatoday.com/news/health/yourhealth/2006-05-21-practice-makes-perfect_x.htm . Accessed 2009 March 29.
243. Moore G. Going Solo: Making the Leap. Family Practice Management, February 2002. Accessed at: http://www.aafp.org/fpm/20020200/29goin.pdf . Accessed 2009 March 29.

244. Moore G, Wasson J. The Ideal Medical Practice Model: Improving Efficiency, Quality and the Doctor-Patient Relationship. Family Practice Management, September 2007. Accessed at: http://www.aafp.org/fpm/20070900/20thei.html . Accessed 2009 March 29.
245. Ho L. 7 Strategies for Creating a More Efficient Practice. Family Practice Management. September 2007. Accessed at: http://www.aafp.org/fpm/20070900/27seve.html . Accessed 2009 March 29.
246. Poon E, Blumenthal D, Jaggi T, Honour M, Bates D, Kaushal R. Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. Hospitals. Health Affairs 23 (4) (2004).
247. Aarts J, Ash J, Berg M. Extending the understanding of computerized physician order entry: Implications for professional collaboration, workflow and quality of care. International Journal of Medical Informatics 76S (2007) S4–S13.
248. Leape LL, Brennan TA, Laird NM, et al. The nature of adverse events in hospitalized patients. N Engl J Med. 1991; 324:377-384.
249. Kaushal R, Shojania KG, Bates DW. Effects of Computerized Physician Order Entry and Clinical Decision Support Systems on Medication Safety: A Systematic Review. Archives of Internal Medicine. Volume 163(12) 23 June 2003 p 1409–1416.
250. Scanlon M. Computer Physician Order Entry and the Real World: We're Only Humans. Joint Commission Journal on Quality and Safety. June 2004, Volume 30, Number 6.
251. Rochon PA, Field TS, Bates DW, Lee M, Gavendo L, Erramuspe-Mainard J, Judge J, Gurwitz JH. Clinical application of a computerized system for physician order entry with clinical decision support to prevent adverse drug events in long-term care. Canadian Medical Association Journal, January 3, 2006, 174(1), 52.
252. Beuscart-Zephira MC, Pelayo S, Anceaux F, Meaux JJ, Degroisse M, Degoulet P. Impact of CPOE on doctor—nurse cooperation for the medication ordering and administration process. International Journal of Medical Informatics (2005) 74, 629—641.
253. Ludwick DA, Doucette J. Adopting electronic medical records in primary care: Lessons learned from health information systems implementation experience in seven countries. Int J Med Inform 2008;78(1):22-31. doi:10.1016/j.ijmedinf.2008.06.005.
254. Ludwick DA, Doucette J. Improve office efficiency by putting your patients to work: Case Study Part 1 of 3: Workflow implications of an online self-service appointment scheduling system in family practice. ElectronicHealthcare, Accepted July 2009.
255. Ludwick DA, Doucette J. Improve office efficiency by putting your patients to work: Case Study Part 2 of 3: The financial viability of an online self-service appointment scheduling system in family practice. ElectronicHealthcare, Accepted July 2009.
256. Ludwick DA, Doucette J. Improve office efficiency by putting your patients to work: Case Study Part 3 of 3: Patients' perspectives regarding online self-service appointment scheduling in family practice. ElectronicHealthcare, Accepted July 2009.
257. U.S. National Library of Medicine. Fact Sheet What's the Difference Between MEDLINE and PubMed? Accessed at: http://www.nlm.nih.gov/pubs/factsheets/dif_med_pub.html . Accessed 2009 April 1.
258. Certification Commission for Healthcare Information Technology. CCHIT Certified Electronic Health Records Reduce Malpractice Risk The Case for Offering Liability Insurance Premium Credits to Physicians Who Use Them. 2007. Accessed at: http://www.cchit.org/files/wpCCHITPhysicianBusinessCaseforCertEHR.pdf . Accessed 2009 March 29.
259. Miller WL, Crabtree BF. The dance of interpretation. In: Crabtree BF, Miller WL, eds. Doing Qualitative Research. 2nd ed. Thousand Oaks, Calif: Sage Publications; 1999:127–143.
260. Borkan J. Immersion/crystallization. In: Crabtree BF, Miller WL, eds. Doing Qualitative Research. 2nd ed. Thousand Oaks, Calif: Sage Publications; 1999:179–194.
261. Hawkins CN, Adas S, Lauzon G, Alanen KW, Rao J. Telehealth for Dermatology: A prospective, multicentre study to evaluate the efficiency, diagnostic capacity and patient attitudes towards dermatological consultation using store-and-forward telemedicine. Capital Health, Edmonton, Alberta, Canada.
262. Ludwick D. Online Self-Service In A Canadian Family Practice: Implementing an Online Self-Service Appointment Scheduling System. Accelerating Primary Care 2009. February 7, 2009.
263. Berg M. Patient care information systems and health care work: a sociotechnical approach. International Journal of Medical Informatics 55 (1999) 87–101.
264. Robbins SP, Langton N. Organizational Behaviour. Concepts, Controversies, Applications. 3rd Canadian Edition. Pearson Education Canada Inc., Toronto, Ontario.
265. Reinertsen JL, Gosfield AG, Rupp W, Whittington JW. Engaging Physicians in a Shared Quality Agenda. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare Improvement; 2007. Accessed at: http://www.ihi.org/IHI/Results/WhitePapers/EngagingPhysiciansWhitePaper.htm . Accessed 2009 March 5.
266. Goorman E, Berg M. Modelling nursing activities: electronic patient records and their discontents. Nurs. Inq. 7 (1) (2000) 3–9.

267. Reddy M, Pratt W, Dourish P, Shabot MM. Sociotechnical Requirements Analysis for Clinical Systems. Methods Inf Med. 2003; 42: 437-44.
268. Rosenbloom ST, Harrell FE, Lehmann CU, Schneider JH, Spooner A, Johnson KB. Perceived Increase in Mortality After Process and Policy Changes Implemented With Computerized Physician Order Entry. Pediatrics. 2006;117;1452-1455.
269. Ash JS, Sittig DF, Dykstra RH, Guappone K, Carpenter JD , Seshadri V. Categorizing the unintended sociotechnical consequences of computerized provider order entry. International Journal of Medical Informatics. 76S (2007) S21–S27.
270. Wagner EH, Austin BT, Davis C, Hindmarsh M, Schaefer J, Bonomi A. Improving chronic illness care: translating evidence into action. Health Aff. (Millwood) 2001 Nov-Dec; 20(6):64-78.
271. Cabana MD, Rand CS, Powe NR, Wu AW, Wilson MH, Abboud PA, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. JAMA 1999 Oct 20;282(15):1458-1465.
272. Martin D, Mariani J, Rouncefield M. Implementing an HIS project: everyday features and practicalities of NHS project work. Health Informatics Journal. 2004; 10; 303
273. Miranda D, Fields W, Lund K. Lessons Learned During 15 Years of Clinical Information System Experience. Computers Informatics Nursing, Vol. 19, No. 4, 147–151.
274. Crosson JC, Stroebel C, Scott JG, Stello B, Crabtree BF. Implementing an Electronic Medical Record in a Family Medicine Practice: Communication, Decision Making, and Conflict. Annals of Family Medicine. Vol. D, No. 4, July/August 2005.
275. Del Beccaro MA, Jefferies HE, Eisenberg MA, Harry ED. Computerized Provider Order Entry Implementation: No Association With Increased Mortality Rates in an Intensive Care Unit. Pediatrics 2006; 118;290-295.
276. Nowinski CJ, Becker SM, Reynolds KS, Beaumont JL, Caprini CA, Hahn EA, Peres A, Arnold BJ. The impact of converting to an electronic health record on organizational culture and quality improvement. International Journal of Medical Informatics 76S (2007) S174–S183.
277. Smith J. Electronic medical records offer compelling reasons for switching from paper-based charts, but what about the human impact? BCMJ, Vol. 50, No. 10, December 2008.
278. Wears RL, Berg M. Computer Technology and Clinical Work: Still Waiting for Godot. JAMA. Vol. 293, No. 10
279. Royal College of General Practitioners. Putting IT into the NHS: all about NPfIT and the national data spine. The New Generalist 2003;1(3)59-60.
280. Brown M, Shaw NT, Grimm NA, Muttitt SC, Gebran J. Electronic Health Records and Patient Safety: What Lessons Can Canada Learn from the Experience of Others? Healthcare Quarterly Vol. 11, No. 1, 2008.
281. Trachtenbarg DE. EHRs Fix Everything – and Nine Other Myths. Family Practice Management. 2007. Accessed at: http://www.aafp.org/fpm/20070300/26ehrs.html . Accessed 2009 March 29.
282. Ball MJ, Garets DE, Handler TJ. Leveraging information technology towards enhancing patient care and a culture of safety in the US. Methods of Information in Medicine. 42(5):503-8, 2003.
283. Ferris N. IT no cure-all for prescription errors. Government Health IT. Accessed at: http://www.govhealthit.com/online/news/89944-1.html . Accessed 2009 March 29.
284. The College of Family Physicians of Canada. Enabling Factors. 2007. Accessed at: http://toolkit.cfpc.ca/en/information-technology/financial-support.php . Accessed 2009 January 3.
285. Henderson J, Britt H, Miller G. Extent and utilisation of computerisation in Australian general practice. Med J Aust. 2006 Jul 17;185(2):84-7.
286. Physician Office System Program. Critical Care for Your Electronic Data. Edmonton, Alberta. 2005. Accessed at: http://www.posp.ab.ca/files/CriticalCareforyourElectronicData.pdf . Accessed 2009 March 29.
287. Physician Office System Program. System Management Guidelines. Edmonton, Alberta. 2006. Accessed at: http://www.posp.ab.ca/files/SystemManagementGuidelines_001.pdf . Accessed 2009 March 29.
288. Gryfe CI. Getting physicians to accept new information technology. Canadian Medical Association Journal. 21 July 2006.
289. Ash JS, Berg M, Coiera E. Some Unintended Consequences of Information Technology in Health Care: The Nature of Patient Care Information System-related Errors. Journal of American Medical Informatics Association. 2004; 11(2):104-112.
290. Mills PD, Weeks WB. Characteristics of successful quality improvement teams: lessons from five collaborative projects in the VA. Jt. Comm. J. Qual. Saf. 2004 Mar;30(3):152-162
291. Balding C. Embedding organisational quality improvement through middle manager ownership. Int J Health Care Qual Assur Inc Leadersh Health Serv. 2005;18(4-5):271-88.
292. Protti D. International experiences in implementing 'single care' record approaches. NHS Connecting for Health, Management Brief No. 6, October 2007.
293. Amatayakul M, Stratis Health. Implementation Strategies. October 15, 2005. Accessed at: http://www.stratishealth.org/clientuploads/pdfs/DOQIT_EHRImplementationPlan_012907.pdf. Accessed 2009 January 4.
294. Lorenzi NM, Riley RT. Organizational issues=change. International Journal of Medical Informatics. 2003;69;197-203.

295. Luo JS. Computer Physician Order Entry: To Implement or Not? Primary Psychiatry. 2006;13(3):19-21.
296. Scott JT, Rundall TG, Vogt TM, Hsu J. Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study. BMJ. 2005;331;1313-1316.
297. Troyan S, Langton KB, Keshavjee K, Holbrook AM. How To Succeed at Implementing EMRs in Small Primary Care Physicians' Offices. Centre for Evaluation of Medicines. St Joseph's Hospital and McMaster University, Hamilton, ON. Accessed at: http://www.compete-study.com/documents/How_to_Succeed_at_Implementing_EMRs_in_Small_Primary_Care_Physicians%27_Offices.pdf . Accessed 2009 March 29.
298. Lapointe L, Rivard S. Getting physicians to accept new information technology: insights from case studies. Canadian Medical Association Journal. May 23, 2006, 174(11).
299. Ryan S. Preparing Your Practice for the Electronic Health Record. Presentation to the Pennsylvania Medical Society. Accessed at: http://www.brainshark.com/brainshark/vu/view.asp?pi=864012747 . Accessed 2007 December 5.
300. eHealth IMPACT. 2005. Study on Economic Impact of eHealth: Developing an evidence-based context-adaptive method of evaluation for eHealth. Descriptive report on site study results: MedCom, Denmark - Danish Health Data Network (DHDN). Accessed at: http://www.ehealth-impact.org/case_tool/data/binary/d60e84cfe6b82cf66c5c9443defcccb0.pdf . Accessed 2009 March 29.
301. Upperman JS, Staley P, Friend K, Benes J, Dailey J, Neches W, Wiener ES. The Introduction of Computerized Physician Order Entry and Change Management in a Tertiary Pediatric Hospital. Pediatrics. 2005;116;634-e642.
302. Izzo JB. Values shift: Recruiting, retaining and engaging the multigenerational Workforce, 2nd Edition. 2007. British Columbia: FairWinds Press.
303. Øvretveit J, Scott T, Rundall TG, Shortell SM, Brommels M. Improving quality through effective implementation of information technology in healthcare. International Journal for Quality in Health Care; Volume 19, Number 5: pp. 259–266.
304. Smith J. Choosing an EMR Vendor. British Columbia Medical Journal, Vol. 51, No. 2, March 2009.
305. Physician Office System Program. Privacy Impact Assessment FAQs. Accessed at: http://www.posp.ab.ca/implementing/privacy-impact-assessment-faqs.asp . Accessed 2009 February 14.
306. Delaney R. Smiling All The Way. Health Care & Informatics Review Online. 1 June 2004. Accessed at: http://www.hinz.org.nz/journal/2004/06/Smiling-All-The-Way/894 . Accessed 2008 December 12.
307. Gosling AS, Westbrook JI, Spencer R. Nurses' use of online clinical evidence. J Adv Nurs 2004;47(2):201-11.
308. Ahmad A, Teater P, Bentley TD, Kuehn L, Kumar R, Thomas A, Mekhjian HS. Key Attributes of a Successful Physician Order Entry System Implementation in a Multi-hospital Environment. J Am Med Inform Assoc. 2002 Jan-Feb;9(1):16-24.
309. Protti D. The Benefits of Computer Technology Can Only Be Realised When Systems of Work are Changed. NHS Connecting for Health, World View Report 6, 18 March 2005. Accessed at: http://www.connectingforhealth.nhs.uk/newsroom/worldview/protti6 . Accessed 2009 January 4.
310. Amatayakul M, Stratis Health. Organizing Your Efforts. October 15, 2005. Accessed at: http://www.stratishealth.org/clientuploads/documents/10.15.05_OrganizingYourEfforts.ppt . Accessed 2009 January 4.
311. Health Informatics Society of Australia. A Vision for an Australian Healthcare System Transformed by Health Informatics. November 2007. Accessed at: http://www.hisa.org.au/system/files/u1/rmed_by_Health_Informatics_v8_Public_Release_2.pdf . Accessed 2009 January 4.
312. Duggan C. Implementation Evaluation: HIM Professionals Share Their Experiences Bringing Health IT Online. J AHIMA. 2006 Jun;77(6):52-5.
313. Adler KG. How to Successfully Navigate Your EHR Implementation. Family Practice Management, February 2007. Accessed at: http://www.aafp.org/fpm/20070200/33howt.pdf . Accessed 2009 January 4.
314. eGovernment News. 2005. UK: Staff disengagement could stall UK's health IT programme, says study. 31 August 2005. Accessed at: http://www.epractice.eu/document/900 . Accessed 2009 January 3.
315. Didham R, Martin I. A review of computerised information technology systems in general practice medicine. Health Care & Informatics Review Online. 1 March 2004.
316. Elvitch FR. SNOMED CT: Electronic health record enhances anesthesia patient safety. American Association of Nurse Anesthetists Journal. October 2005, Vol. 73, No. 5
317. Leape LL, Rogers G, Hanna D, Griswold P, Federico F, Fenn CA, et al. Developing and implementing new safe practices: voluntary adoption through statewide collaborative. Qual Saf Health Care. 2006; 15: 289-295. Accessed at: http://qshc.bmj.com/cgi/content/abstract/15/4/289 . Accessed 2009 March 29.
318. Weber V, Joshi MS. Effecting and leading change in health care organizations. Jt. Comm. J. Qual. Improv. 2000 Jul;26(7):388-399.
319. Gold SK, Abelson J, Charles CA. From rhetoric to reality: including patient voices in supporting cancer care planning. Health Expect. 2005 Sep;8(3):195-209.

320. Bate P, Glenn R, McLeod H. Report on the 'Breakthrough' Collaborative approach to quality and service improvement within four regions of the NHS. University of Birmingham Health Services Management Centre School of Public Policy; 2002.
321. Ham C, Kipping R, McLeod H, Meredith P. Capacity, culture and leadership: lessons from experience of improving access to hospital services. Birmingham, UK: Health Services Management Centre, School of Public Policy, University of Birmingham; 2002. Accessed at: http://www.hsmc.bham.ac.uk/publications/pdfs/BAPFinalRep-Jul02.pdf . Accessed 2009 March 29.
322. Ferris N. Medical mishaps - Conventional wisdom holds that electronic medical records will reduce medical errors in the United States, but there's surprisingly little evidence to back that up. Government Health IT. Accessed at: http://www.govhealthit.com/print/4_2/news/97676-1.html Accessed 2009 March 29.
323. Korst LM, Eusebio-Angeja AC, Chamorro T, Aydin CE, Gregory KD. Nursing Documentation Time During Implementation of an Electronic Medical Record. Journal of Nursing Administration. Volume 33, Number 1, pp 24-30.
324. Protti D, Edworthy S, Johansen I. Adoption of Information Technology in Primary Care Physician Offices in Alberta and Denmark, Part 1: Historical, Technical and Cultural Forces. ElectronicHealthcare. Vol. 6, No. 1.
325. Pilling JR. Lessons Learned from a Whole Hospital PACS Installation. Clinical Radiology 2002;57;784-788.
326. Hsu J, Huang J, Fung V, Robertson N, Jimison H, Frankel R. Health Information Technology and Physician-Patient Interactions: Impact of Computers on Communication during Outpatient Primary Care Visits. J Am Med Inform Assoc. 2005;12:474–480. DOI 10.1197/jamia.M1741.
327. Keshavjee K, Troyan S, Holbrook AM, VanderMolen D, COMPLETE I. Measuring the success of electronic medical record implementation using electronic and survey data. Proceedings/AMIA Annual Symposium 2001;309–13.
328. Aarts J, Dooreward H, Berg M. Understanding Implementation: The Case of a Computerized Physician Order Entry System in a Large Dutch University Medical Center. Journal of the American Medical Informatics Association 11: 207-16.
329. Berg M. Implementing Information Systems in Health Care Organizations: Myths and Challenges. International Journal of Medical Informatics 64: 143-45.
330. Tsai AC, Morton SC, Mangione CM, Keeler BE. A meta-analysis of interventions to improve care for chronic illnesses. Am J Manag Care 2005 Aug;11(8):478-488.
331. Hroscikoski MC, Solberg LI, Sperl-Hillen JM, Harper JG, McGrail MP, Crabtree BF. Challenges of change: a qualitative study of chronic care model implementation. Ann Fam Med. 2006 Jul-Aug;4(4):317-326.
332. Thomas P, McDonnell J, McCulloch J, While A, Bosanquet N, Ferlie E. Increasing capacity for innovation in bureaucratic primary care organizations: a whole system participatory action research project. Ann Fam Med. 2005 July-Aug;3(4):312-317.
333. Pizziferri L, Kittler AF, Volk LA, Honour MM, Gupta S, Wang S, Wang T, Lippincott M, Li Q, Bates DW. Primary care physician time utilization before and after implementation of an electronic health record: A time-motion study. Journal of Biomedical Informatics 38 (2005) 176–188.
334. Wong DH, Gallegos Y, Weinger MB, Clack S, Slagle J, Cynthia T. Anderson CT. Changes in intensive care unit nurse task activity after installation of a third-generation intensive care unit information system. Critical Care Medicine. 2003 Vol. 31, No. 10.
335. Rodriguez NJ, Murillo V, Borges JA, Ortiz J, Sands DZ. A usability study of physicians interaction with a paper-based patient record system and a graphical-based electronic patient record system. Proceedings/AMIA Annual Symposium 2002; 667–71.
336. Shu K, Boyle D, Spurr C, Horsky J, Heiman H, OConnor P, et al. Comparison of time spent writing orders on paper with computerized physician order entry. Medinfo 2001;10(Pt:2): 2–11.
337. McGrath JM, Arar NH, Pugh JA. The influence of electronic medical record usage on nonverbal communication in the medical interview. Health Informatics Journal 2007; 13; 105.
338. Overhage JM, Perkins S, Tierney WM, McDonald CJ. Controlled trial of direct physician order entry: effects on physicians' time utilization in ambulatory primary care internal medicine practices. J Am Med Inform Assoc 2001;8(4):361–71.
339. Rancourt J-F. Experiences from the forefront of Electronic Medical Record (EMR) implementation and use in Canadain primary care settings. Presentation to eHealth 2009, Quebec City, PQ, June 3, 2009.
340. Ludwick D, Doucette J. The Role of Change Management in the Deployment of Physician Office Systems. Presented to eHealth Canada, May 2008, Vancouver, British Columbia, Canada.
341. Sherwood Park – Strathcona County Primary Care Network. Sherwood Park – Strathcona County Primary Care Network. Accessed at: http://www.sherwoodparkpcn.com . Accessed 2009 March 21.
342. Alberta Medical Association. Data migration vendor chosen for POSP. MDScope. March 12, 2009. Accessed at: http://www.industrymailout.com/Industry/LandingPage.aspx?id=358478&lm=13889681&q=117285309&qz=7247defcfef303e24f6931b6162628d4 . Accessed 2009 March 14.
343. Beck RS, Daughtridge R, Sloane PD. Physician-Patient Communication in the Primary Care Office: A Systematic Review. J Am Board Fam Pract 2002;15: 25–38.

344. Patel VL, Arocha JF, Kushniruk AW. Patients' and physicians' understanding of health and biomedical concepts: relationship to the design of EMR systems. Journal of Biomedical Informatics 35 (2002) 8–16.
345. Stewart M. Effective Physician-Patient Communication and Health Outcomes: A review. CMAJ. May 1, 1995; 152 (9).
346. Cegala DJ, Marinelli T, Post D M. The effect of patient communication skills training on treatment compliance in primary care. Archives Family Medicine 2000; 9; 448–57.
347. Stewart MA. Effective physician–patient communication and health care outcomes: a review. Canadian Medical Association Journal 1995; 152; 1423–33.
348. Ong LM, deHaes J C, Hoos AM, Lammes FB. Doctor–patient communication: a review of the literature. Social Science & Medicine 1995; 40; 903–18.
349. Mehrabian, A. (1971). Silent messages. Wadsworth, Belmont, California. Accessed at: http://en.wikipedia.org/wiki/Albert_Mehrabian . Accessed 2009 March 29.
350. Burgoon JK, Hoobler GD. Nonverbal signals. In Knapp M L, Daly J A eds. Handbook of Interpersonal Communication 3rd edn, 240–99. Thousand Oaks, CA: Sage, 2002.
351. Frankel R, Altschuler A, George S, Kinsman J, Jimison H, Robertson NR, Hsu J. Effects of Exam-Room Computing on Clinician–Patient Communication. A Longitudinal Qualitative Study. J Gen Intern Med 2005; 20:677–682.
352. Makoul G, Curry RH, Tang PC. The Use of Electronic Medical Records: Communication Patterns in Outpatient Encounters. J Am Med Inform Assoc. 2001;8:610–615.
353. Wells JE. Efficient Office Design for a Successful Practice. Family Practice Management. May 2007. Accessible at: http://www.aafp.org/fpm/20070500/46effi.html. Accessed 2009 June 1.
354. Pagliari C, Gilmour M, Sullivan F. Electronic clinical communications implementation (ECCI) in Scotland: a mixed-methods programme evaluation. J Eval Clin Pract. 2004;10:11–20.
355. Edsall RL, Adler KG. User Satisfaction With EHRs: Report of a Survey of 422 Family Physicians. Family Practice Management. February 2008. Accessed at: http://www.aafp.org/fpm/20080200/25user.pdf . Accessed 2009 March 29.
356. Keshavjee K, Kyba R, Naisbitt P, Holbrook AM. Electronic Medical Records in Family Practice: What drives physician interest and how much are they willing to pay? Computerization of Medical Practice for the Enhancements of Therapeutic Effectiveness. Accessed at: http://www.compete-study.com/documents/EMRs_in_Family_Practice-What_drives_physician_interest_and_how_much_are_they_willing_to_pay.pdf . Accessed 2009 March 29.
357. Ammenwerth E, Talmon J, Ash JS, Bates DW, Beuscart-Zephir MC, Duhamel A et al. Impact of CPOE on mortality rates--contradictory findings, important messages. Methods of Information in Medicine. 2006; 45(6):586-593.
358. Linder JA, Ma J, Bates DW, Middleton B, Stafford RS. Electronic Health Record Use and the Quality of Ambulatory Care in the United States. Archives of Internal Medicine.. Vol. 167 (No. 13), July 9, 2007.
359. Adams WG, Mann AM, Bauchner H. Use of an Electronic Medical Record Improves the Quality of Urban Pediatric Primary Care. Pediatrics. Vol. 111, No. 3, March 2003.
360. Bruner A, Kasdan ML. Handwriting Errors: Harmful, Wasteful and Preventable. September 26, 2003. Accessed at: http://www.kyma.org/uploads/file/Patient_Safety/Physicians/Harmful_wasteful_and_preventable.pdf . Accessed 2009 March 5.
361. Fraenkel DJ, Cowie M, Daley P. Quality benefits of an intensive care clinical information system. Crit Care Med 2003 Vol. 31, No. 1.
362. Stead W. Rethinking Electronic Health Records to Better Achieve Quality and Safety Goals. Annu. Rev. Med. 2007. 58:35–47.
363. Johnson K, Bowen S, Zhang L, Kreindler SA. Evaluation of the Manitoba Demonstration Project in Physician Demand-Side Control for Diagnostic Imaging. Winnipeg, MB: WRHA; 2007.
364. Currell R, Urquhart C. Nursing record systems: effects on nursing practice and health care outcomes. Cochrane Database of Systematic Reviews. 2003, Issue 3. Art. No.: CD002099. DOI: 10.1002/14651858.CD002099.
365. Hamilton WT, Round AP, Sharp D. Peters TJ. The quality of record keeping in primary care: a comparison of computerised, paper and hybrid systems. British Journal of General Practice, 2003, 53, 929-933. Accessed at: http://www.pubmedcentral.nih.gov/picrender.fcgi?artid=1314745&blobtype=pdf . Accessed 2009 March 29.
366. Coiera EW, Westbrook JI. Should clinical software be regulated? Medical Journal of Australia. 2006; 184 (12): 600-601. Accessed at: http://www.mja.com.au/public/issues/184_12_190606/coi10287_fm.pdf . Accessed 2009 March 29.
367. Chappell DA. Enterprise Service Bus: Theory and Practice. Sebastopol, CA: O'Reilly Media, Inc. 2004.
368. Ludwick DA, Doucette J. Case Study: The Effect of Information and Computing Technology on Health Care: The Implications of Operational Processes. Presented to itSMF 2007 Canadian National Conference, May 29, 2007, Calgary, Alberta, Canada.
369. Ludwick DA. Case Study: The Alberta EHR. The Effect of Information and Computing Technology on Health Care: The Implications of Operational Processes in Government and Primary Care. Presented to eHealth Canada, May 2008, Vancouver, British Columbia, Canada. May 2008.

370. itSMF Canada. About ITIL (R). Accessed at: http://www.itsmf.ca/about/itil.html . Accessed 2009 September 25.
371. Verzuh E. The Fast Forward MBA in Project Management. Third Edition. John Wiley & Sons, Inc., Hoboken, New Jersey. 2008.
372. Anderson JG. Social, ethical and legal barriers to E-health. International Journal of Medical Informatics. 76 (2007) 480–483. Accessed at: http://download.journals.elsevierhealth.com/pdfs/journals/1386-5056/PIIS1386505606002218.pdf . Accessed 2009 March 29.
373. Robinson B. Survey: EHR a tough sell. Government Health IT. Accessed at: http://www.govhealthit.com/online/news/90792-1.html . Accessed 2009 March 29.
374. Grieger DL, Cohen SH, Krusch DA. A Pilot Study to Document the Return on Investment for Implementing an Ambulatory Electronic Health Record at an Academic Medical Center. Journal of the American College of Surgeons. doi: 10.1016/j.jamcollsurg. 2007.02.074.
375. Levick D, Lukens HF, Stillman PL. You've led the horse to water, now how do you get him to drink: managing change and increasing utilization of computerized provider order entry. Journal of Healthcare Information Management. 19(1):70-5, 2005.
376. Physician Information Technology Office. Implementation & Transition Support Program. Version 1.1, May 2008. Accessed at: http://www.pito.bc.ca/Programs/ITSP.htm . Accessed 2009 March 29.
377. Physician Office System Program. Transition Services Overview. Version 1, June 2008. Accessed at: http://www.posp.ab.ca/files/POSPTransitionServices-Overview.pdf . Accessed 2009 March 29.
378. OntarioMD. Transition Support Program. Frequently Asked Questions. Accessed at: https://www.ontariomd.ca/portal/server.pt?space=CommunityPage&cached=true&parentname=CommunityPage&parentid=0&in_hi_userid=2&control=SetCommunity&CommunityID=477&PageID=1515 . Accessed 2009 February 14.
379. Certification Commission for Healthcare Information Technology. 2007 Physician's Guide to Certification for Ambulatory Electronic Health Records. Accessed at: http://www.cchit.org/files/CCHITPhysiciansGuide2007.pdf . Accessed 2009 March 29.
380. Personal conversation with Roy Robb, Director of Information Technology, Saskatchewan Medical Association. October 10, 2008.
381. Certification Commission for Health Information Technology. The CCHIT Incentive Index™ Funding abounds for adoption of certified EHRs and other health IT. September 25, 2008. Accessed at: http://ehrdecisions.com/wp-content/files/CCHITIncentiveIndex20080925.pdf . Accessed 2009 March 29.
382. Hoeksma J. Inside e-health on (not) getting results out of the box. January 29, 2008. Accessed at: http://www.microsoft.com/uk/nhs/content/articles/inside-e-health-on-not-getting-results-out-of-the-box.aspx . Accessed 2009 March 29.
383. Personal correspondence with Debbie Chinn and Ian Harrison. National Integration Centre. September 2, 2008.
384. South Dakota Foundation for Medical Care. Letters from the Medical Director – Electronic Health Record Certification. June 2008. Accessed at: http://www.sdfmc.org/Professionals/LettersfromtheMedicalDirector/NewsDetail181.cfm?Id=50,1203 . Accessed 2008 September 8.
385. Certification Commission for Healthcare Information Technology. Physician's Guide to Certification for 08 EHRs. Accessed at: http://www.cchit.org/files/CCHITPhysiciansGuide08.pdf . Accessed 2009 February 15.
386. Golbey M. PITO Responds – Personal View. British Columbia Medical Journal, Vol. 50, No. 1, January/February 2008. Accessed at: http://www.bcmj.org/pito-responds . Accessed 2009 February 15.
387. Smith J. PITO Replies – Personal View. British Columbia Medical Journal, Vol. 50, No. 3, April 2008. Accessed at: http://www.bcmj.org/pito-replies . Accessed 2009 February 15.
388. Grossman JM, Cohen G. Despite Regulatory Changes, Hospitals Cautious in Helping Physicians Purchase Electronic Medical Records. Centre for Studying Health System Change. Issue Brief No. 123, September 2008. Accessed at: http://www.hschange.org/CONTENT/1015/1015.pdf . Accessed 2009 March 29.
389. Homchick RG. Physician Self-Referral and Anti-Kickback Laws Pose Threats to Development of Community Health Information Networks. Advisory Bulletin, Davis Wright Tremaine LLP, Seattle, Wash. (October 2004). Accessed at: http://www.dwt.com/practc/hit/bulletins/10-04_Stark.htm . Accessed 2009 March 29.
390. Niebergal D. CHITTA Revitalized for the Future. June 2006, Accessed at: http://sl.infoway-inforoute.ca/downloads/Dennis_Niebergal_-_CHITTA_Revitalized_for_the_Future.pdf . Accessed 2009 March 29.
391. Manitoba eHealth. FAQ about the EMR Qualification Process. Accessed at: http://www.manitoba-ehealth.ca/dr-EMRFaq.html . Accessed 2009 March 29.
392. Physician Office System Program. POS Program Funding Overview. Version 2, June 2008. Accessed at: http://www.posp.ab.ca/files/POSPProgramFunding-Overview.pdf . Accessed 2009 March 29.
393. Physician Information Technology Office. Funding Information Sheet. Version 1.1, May 2008. Accessed at: http://www.pito.bc.ca/Documents/PITO%20Funding%20Info%20Sheet_Final%20%20v1.2%2008-11-12.pdf . Accessed 2009 March 29.

394. Rich P, Fletcher M. Toolkits and tips: resources to implement IT. Future Practice, Canadian Medical Association, 19 June 2007. Accessed at: http://www.cma.ca/multimedia/CMA/Content_Images/Inside_cma/Future_Practice/English/2007/June/FP0607_toolkit.pdf . Accessed 2009 March 29.
395. Dueck C-A, O'Keefe M. Measuring and Rewarding Quality. How EMRs are Helping Manitoba's Physician Integrated Network Renew Primary Care through Quality-Based Incentive Funding, 2008, Accessed at: http://www.gov.mb.ca/health/phc/pin/docs/ehealth.pdf . Accessed 2009 March 29.
396. Personal conversation with David Ullis, Executive Director, Physician Office System Program. September 9, 2008.
397. Physician Information Technology Office. Frequently Asked Questions. Accessed at: http://www.pito.bc.ca/faq/faq.htm . Accessed 2009 March 29.
398. Saskatchewan Medical Association. 2007 Fall Meeting of the Representative Assembly, November 2 and 3, 2007. Accessed at: http://www.sma.sk.ca/communications/RAReports/RA%20Report%20Book%20Nov%202007%20for%20web.pdf . Accessed 2009 March 29.
399. Alberta Medical Association. Mentoring service valuable for POSP physicians. E-MD Scope, May 22, 2008. Accessed at: http://www.industrymailout.com/Industry/LandingPage.aspx?id=238176&p=1 . Accessed 2009 March 29.
400. Protti D. Comparison of Information Technology in General Practice in 10 Countries, Healthcare Quarterly. Vol. 10, No. 2, 2007.
401. Protti D, Wright G, Treweek S, Johansen I. Primary care computing in England and Scotland: a comparison with Denmark. Informatics in Primary Care. 2006;14:93-9.
402. Protti D. US Regional Health Information Organizations and the Nationwide Health Information Network: Any Lessons for Canadians? Healthcare Quarterly. Vol. 11, No. 2, 2008.
403. Physician Information Technology Office. Communities of Practice Program. Accessed at: http://www.pito.bc.ca/Documents/Communities%20of%20Practice%20Overview%20v1.1%2008-05-14.pdf Accessed 2009 March 29.
404. Murray M. Answers to Your Questions About Same-Day Scheduling. Family Practice Management, March 2005. Accessed at: http://www.aafp.org/fpm/20050300/59answ.html . Accessed 2009 March 18.
405. Murray M. Access Improvement: How to do it Differently. Presentation to the 9th Annual International Summit on Redesigning the Clinical Office Practice. March 31, 2008, Dallas, Texas.
406. Raddish M, Hord SD, Sharkey PD. Continuity of care: Is it cost effective? Am J Manage Care. 1999; 5:727-734.
407. Schectman G, Barnas G, Laud P, et al. Prolonging the return visit interval in primary care. Am J Med. 2005; 118(4):393-399.
408. Grumbach K, Bodenheimer T. Can health care teams improve primary care practice? JAMA. 2004;291:1246-1251.
409. Moores DG, Wilson DR, Cave AJ, Woodhead Lyons SC, Donoff MG. Improving the Quality and Capacity of Canada's Health Services: Primary Care Physicians Perspectives. Healthcare Policy, Vol. 3, No. 2, 2007.
410. Ettner SL. The relationship between continuity of care and the health behaviours of patients: does having a usual physician make a difference? Med Care. 1999;37:547-555.
411. Deitrich AJ, Marton KI. Does continuous care from a physician make a difference? J Fam Pract. 1982;15:929-937.
412. Davis JE, McBride PE, Bobula JA. Improving prevention in primary care: physicians, patients and process. J Fam Pract. 1992;;35(4):385-387.
413. Taplin S, Galvin MS, Payne T, Coole D, Wagner E. Putting population based care into practice: real option or rhetoric? J Am Board Fam Pract. 1998; 11(2): 116-126.
414. Carney PA, Deitrich AJ, Keller A, Landgraf J, O'Connor GT. Tool, teamwork and tenacity: an office system for cancer prevention. J Fam Pract. 1992;35(4):388-394.
415. Wikipedia. Automated Teller Machines. Accessed at: http://en.wikipedia.org/wiki/Automated_teller_machine . Accessed 2009 March 29.
416. Aerospace & Defence Network. Aerospace. Defence, Aviation, Security & Space Editorials. E-ticket revolution. Accessed at: http://www.asd-network.com/editorial_detail/15/E-ticket_revolution.htm . Accessed 2009 March 29.
417. United States Department of Labor. Career Guide to Industries – Grocery Stores. March 12, 2008. Accessed at: http://www.bls.gov/oco/cg/cgs024.htm . Accessed 2009 March 29.
418. Amirault M, Cobbett S, Doherty A, Hartigan-Rogers J, LeBlanc A, Muise-Davis M, Newell J. Consumer health information on the Internet: an evaluation report of h the Nova Scotia Health Network. JCHLA/JABSC 26: 41-46 (2005). Accessed at: http://article.pubs.nrc-cnrc.gc.ca/RPAS/rpv?hm=HInit&calyLang=eng&journal=jchla&volume=26&afpf=c05-013.pdf . Accessed 2009 August 31.

419. Valdes I, Kibbe DC, Tolleson G, Kunik ME, Petersen LA. Barriers to proliferation of electronic medical records. Inform Prim Care. 2004;12: 3–9.
420. Newslink. New LSP internet booking system for patients in Bradford and Airedale, Issue 13, September 2008. Accessed at: http://www.yorksandhumber.nhs.uk/document.php?o=1540 . Accessed 2009 March 29.
421. Fenton SH, Giannangelo K, Stanfill M. Essential People Skills for EHR Implementation Success (AHIMA Practice Brief). Journal of AHIMA 77, no.6 (June 2006): 60A-D.
422. Fenton SH, Amatayakul M, Work M. HIM Impact on EHRs: Newly Released Study Links HIM Professionals and Successful EHR Implementations. Journal of AHIMA 77, no.9 (October 2006): 36-40.
423. Gray MD, Felkey BG. Computerized prescriber order-entry systems: Evaluation, selection, and implementation. Am J Health-Syst Pharm. 2004; 61:190-7.
424. Balling Høstgaard, AM. Change readiness research: A qualitative study of variations in participation. Ubiquity: 2006. pp. 705-710. Accessed at: http://www.booksonline.iospress.nl/Content/View.aspx?piid=3851 . Accessed 2009 March 28.
425. Miller R, Sim I, Newman J. Electronic medical records: lessons from small physician practices . University of California, San Francisco. Oakland, CA: California Healthcare Foundation. October 2003. Accessed at: http://www.chcf.org/documents/ihealth/EMRLessonsSmallPhyscianPractices.pdf . Accessed 2009 March 29.
426. Med Access. About us. 2007. Accessed at: http://www.med-access.net/about.php . Accessed 2009 March 14.
427. Wolf Medical Systems. Management. 2007. Accessed at: http://www.wolfmedical.com/management.html . Accessed 2009 March 14.
428. Physician Office System Program. Frequently Asked Questions: RFP Process. Accessed at: http://www.posp.ab.ca/files/POSP-FAQ-Oct08.pdf . Accessed 2009 March 14.
429. Physician Information Technology Office. Privacy Information Sheet. Accessed at: http://www.pito.bc.ca/Documents/PITO%20Privacy%20Info%20Sheet_Final%20%20v1.1%2008-05-14.pdf . Accessed 2009 February 14.
430. Manitoba eHealth. Using Technology to meet Manitoba health care needs. Accessed at: http://www.manitoba-ehealth.ca/technology.html . Accessed 2009 February 14.
431. Alberta Health and Wellness. Privacy Impact Assessments (PIAs) and Organizational Readiness Assessments (ORA). Alberta Netcare EHR Newsletter www.albertanetcare.ca Vol. 3, No. 1, January 2007. Accessed at: http://www.albertanetcare.ca/NCnews01-07.pdf . Accessed 2009 February 14.
432. Alberta Primary Care Initiative. PCNs – By the Numbers. InTouch, September 2008. Accessed at: http://www.industrymailout.com/Industry/LandingPage.aspx?id=287914&p=1 . Accessed 2009 March 14.
433. Canadian Psychiatry Association. WHO says primary care delivery of mental health services is cost effective. Canadian Psychiatry Aujourd'hui. February 2009, Vol. 5, No. 1. Accessed at: http://publications.cpa-apc.org/browse/documents/442&xwm=true . Accessed 2009 March 14.
434. The Ontario College of Family Physicians. Mental Health Care in Family Practices. I am asking you: How can we improve the system? "Inside Out": Number 57. September 15, 2008. Accessed at: http://www.ocfp.on.ca/local/files/Letter%20to%20Members%2057.pdf . Accessed 2009 March 14.
435. NHS Institute for Innovation and Improvement. Sustainability and its relationship with spread and adoption. (Improvement Leaders'' Guide 1.7) London: Department of Health; 2006. Accessed at: http://www.institute.nhs.uk/index.php?option=com_content&task=view&id=134&Itemid=351 . Accessed 2009 March 14.

Appendix 1

International Literature Review Search Data

Keywords and Alternate Phrases for Health Information Systems

Clinical Information System	Ambulatory Care System
Hospital Information System	Physician Office System
Computer Physician Order Entry System	Electronic Patient Record
Computer Provider Order Entry System	Electronic Medical Record
Health Information System	Continuity of Care Records
Computerized Patient Record	Electronic Medical Summary
	Electronic Health Record

Care Settings

Primary Care	Long Term Care	Community Care
Secondary Care	Acute Care	Ambulatory Care
Tertiary Care	Emergency Department	General Practice
Quartiary Care	Telehealth	Family Practice

Countries

Canada	United States
Denmark	Australia
Sweden	New Zealand
United Kingdom	

Time frame of review: January 1, 2000 to December 31, 2007
Language: English

Inclusion Criteria

- Include articles which document the implementation or deployment of the patient records management and order entry systems outlined in Table 1. Also, include articles whose discussions and results document implementation outcomes and recommendations.
- Include articles that document systems implementation in care settings listed in Table 2 and from countries listed in Table 3.
- Include articles which discuss the technical system and project implementation approach and experience.
- Include articles which describe change management approaches and comment on the need for change management approaches.
- Include articles which consider implementation risks, conduct risk analyses and consider risk mitigation approaches to minimize threats to patient safety.
- Include articles which focus on both positive and negative outcomes.

- Include articles which document both the technical lessons learned as well as the organizational, cultural or socio-technical implications of the implementations.
- Include both qualitative reviews of implementations as well as studies based on randomized controlled trials which document outcomes with quantitative statistical measures.
- Include articles which ensure that experiments are designed such that patient populations are comparable and that statistical analysis is well founded.
- Include articles that focus on patient outcomes.
- Include articles that focus on clinician oriented outcomes and workflow outcomes.
- Include articles that focus on the financial and economic implications of systems implementation.
- Include articles that are systematic reviews of this area of interest
- Although the advice is intended for general practitioners adopting health information systems in primary care, jurisdictional, systemic or environmental factors in systems implementation can have an effect on care delivery. Concepts such as national approach to health system financing, health human resource strategies, drug policy or health care policy shape many dimensions in health care. Therefore articles that contemplate or illustrate these factors and their effects on implementation processes in primary care are included.

Exclusion Criteria

- Exclude articles that focus on implementation of new workflow processes exclusive of any electronic system implementation. These articles document outcomes of process flow changes only. Our interest is to provide lessons learned to adopters of EMRs.
- Exclude articles that document the implications of systems implementations to specific medical processes or care techniques. General practitioners encounter a wide range of ailments and health issues. Primary care requires general practitioners to be trained in a wide variety of skills and techniques. We do not wish to limit our focus to articles that focus on specific medical processes.
- Exclude articles that focus exclusively on lessons learned at the societal or geopolitical level. Again, general practitioners are practical clinicians who need tangible, every-day guidance in implementing health information systems. The review will focus on papers that advise EMR implementers at the front line of care.
- Exclude articles that focus on the research implications of health information systems. In the advice report, health information systems will be reported as a source of research information; however, again, the focus here is on

providing practical implementation guidance at the front line of primary care delivery.

Sources of Information

Literature Databases and Search Strings

MEDLINE

Search String	('Clinical Information System' OR 'Ambulatory Care System' OR 'Hospital Information System' OR 'Physician Office System' OR 'Computer Physician Order Entry System' OR 'Electronic Patient Record' OR 'Computer Provider Order Entry System' OR 'Electronic Medical Record' OR 'Continuity of Care Records' OR 'Health Information System' OR 'Computerized Patient Record' OR 'Electronic Medical Summary' OR 'Electronic Health Record') AND ('lessons' OR 'outcomes' OR 'advice' OR 'success factors' OR 'implement' OR 'deploy' OR 'change' OR 'risk' OR 'patient safety' OR 'culture' OR 'socio' OR 'technic' OR 'quantit' OR 'quality' OR 'econom')
ti:	As per the above search string
cp:	As per Table 3, manually searched
dp:	2000 to 2007, manually searched
lg:	English, manually searched
All other fields:	Unchecked

PUBMED

MeSH Concepts	Clinical Information System OR Ambulatory Care System OR Hospital Information System OR Physician Office System OR Computer Physician Order Entry System OR Electronic Patient Record OR Computer Provider Order Entry System OR Electronic Medical Record OR Continuity of Care Records OR Health Information System OR Computerized Patient Record OR Electronic Medical Summary OR Electronic Health Record
ANDed with	lessons OR outcomes OR advice OR success factors OR implement* OR deploy* OR change* OR risk* OR patient safety OR culture OR socio* OR technical OR quantity OR quality OR economy
All other fields	Visually examined

CINAHL

Search string:	('Clinical Information System' OR 'Ambulatory Care System' OR 'Hospital Information System' OR 'Physician Office System' OR 'Computer Physician Order Entry System' OR 'Electronic Patient Record' OR 'Computer Provider Order Entry System' OR 'Electronic Medical Record' OR 'Continuity of Care Records' OR 'Health Information System' OR 'Computerized Patient Record' OR 'Electronic Medical Summary' OR 'Electronic Health Record') AND ('lessons' OR 'outcomes' OR 'advice' OR 'success factors' OR 'implement' OR 'deploy' OR 'change' OR 'risk' OR 'patient safety' OR 'culture' OR 'socio' OR 'technical' OR 'quantity' OR 'quality' OR 'economic')
Field:	Ti Title
Full Text Checkbox	Unchecked
References Available Checkbox	Unchecked
Abstract Available Checkbox	Unchecked
Publication Year	2000 to 2007
Published Date from	Blank
Author	Blank
Publication	Blank
Peer Reviewed	Unchecked
Research article	Unchecked
Exclude Pre-CINAHL	Unchecked
CE Module	Unchecked
Journal Subset	All
Publication Type	Abstract, Book, Case Study, Clinical Trial, Conference, Doctoral Dissertation, Interview, Journal Article
Language	English
Gender	All
Pregnancy	Unchecked
Inpatients	Unchecked
Outpatients	Unchecked
Age Groups	All
Special Interest	Evidence Based Practice, Informatics,

EMBASE

Search string	("Clinical Information System" OR "Hospital Information System" OR "Physician Office System" OR "Computer Physician Order Entry System" OR "Electronic Patient Record" OR "Computer Provider Order Entry System" OR "Electronic Medical Record" OR "Continuity of Care Records" OR "Health Information System" OR "Computerized Patient Record" OR "Electronic Medical Summary" OR "Electronic Health Record") AND ("lessons" OR "outcomes" OR "advice" OR "success factors" OR "implement*" OR "deploy*" OR "change*" OR "risk*" OR "patient safety" OR "culture" OR "socio*" OR "technic*" OR "quantit*" OR "quality*" OR "econom*")
ti:	As per above search string
cp:	As per Table 3, manually searched
dp:	2000 to 2007, manually searched
lg:	English, manually searched
All other fields:	Unchecked

The Cochrane Library

Record title	("Clinical Information System" OR "Hospital Information System" OR "Physician Office System" OR "Computer Physician Order Entry System" OR "Electronic Patient Record" OR "Computer Provider Order Entry System" OR "Electronic Medical Record" OR "Continuity of Care Records" OR "Health Information System" OR "Computerized Patient Record" OR "Electronic Medical Summary" OR "Electronic Health Record") AND ("lessons" OR "outcomes" OR "advice" OR "success factors" OR "implement*" OR "deploy*" OR "change*" OR "risk*" OR "patient safety" OR "culture" OR "socio*" OR "technic*" OR "quantit*" OR "quality*" OR "econom*")
Restrict Search By Product	All of the Cochrane Library
Restrict Search By Record Status	All
Date Range	2000 to 2007
All	Blank

other fields	

IEEE Xplore

Boolean Search	((Clinical Information System<in>ti) <or> (Hospital Information System<in>ti) <or> (Physician Office System<in>ti) <or> (Computer Physician order Entry System<in>ti) <or> (Electronic Patient Record<in>ti) <or> (Computer Provider order Entry System<in>ti) <or> (Electronic Medical Record<in>ti) <or> (Continuity of Care Records<in>ti) <or> (Health Information System<in>ti) OR (Computerized Patient Record<in>ti) OR (Electronic Medical Summary<in>ti) OR (Electronic Health Record<in>ti)) <and> ((lessons<in>ti) <or> (outcomes<in>ti) <or> (advice<in>ti) <or> (success factors<in>ti) <or> (implement*<in>ti) <or> (deploy*<in>ti) <or> (change*<in>ti) <or> (risk*<in>ti) <or> (patient safety<in>ti) <or> (culture<in>ti) <or> (socio*<in>ti) <or> (technic*<in>ti) <or> (quantit*<in>ti) <or> (quality*<in>ti) <or> (econom*<in>ti)) <and> (pyr >= 2000 <and> pyr <= 2007)
Publications	IEEE Periodicals, IET Periodicals, IEEE Conference Proceedings, IET Conference Proceedings, IEEE Standards
Date Range	2000 to 2007

Other Sources and Methods

Journal Internet Sites

- Used the search utilities offered on the journal websites to find pertinent articles which may not have been found in database searches.
- Search utilities offered on these sites were not as robust as those offered by the databases,
- Search strategies were modified based on available search features and findings.

Search By Author

- Search by author, rather than topic, using the names of authors who wrote articles which were relevant to the inclusion and exclusion criteria.
- The goal here was to find articles written by authors that could not be found through the searches outlined above but which were still appropriate for review.
- These searches were conducted in the databases.

Mining Article References

- The references of articles were scanned to mine for further relevant articles.

Non-Peer-Reviewed Sources

- The challenge here was to establish a consistent approach to reviewing the sites.
- Since the sites obviously do not follow any defined standard, the search process narrowed down to visual examination of presentations, news, articles and other artefacts which may fit the inclusion and exclusion criteria.
- Sites searched are listed in Appendix 4

General Internet Search

- The search engine used was the Google engine.
- The Google search engine has a different (and simple) interface for searching. Search strings are constrained to a maximum of 32 words long, requiring a series of searches to achieve a comparable result to the searches in the databases.
- The table below documents the search parameters used on the Google Advanced Scholar Search. The search string was split up into 9 different searches to provide a similar search comparison to those in the databases, yet achieve the 32 word search string limit.

Google Advanced Scholar Search Detail

Search variables	**Inputs**
With all the words	String 1 ("Clinical Information System" OR "Hospital Information System" OR "Physician Office System" OR "Computer Physician Order Entry System") + ("lessons" OR "outcomes" OR "advice" OR "success factors" OR "implement" OR "deploy*") String2 ("Electronic Patient Record" OR "Computer Provider Order Entry System" OR "Electronic Medical Record" OR "Continuity of Care Records") + ("lessons" OR "outcomes" OR "advice" OR "success factors" OR "implement" OR "deploy*") String 3 ("Health Information System" OR "Computerized Patient Record" OR "Electronic Medical Summary" OR "Electronic Health Record") + ("lessons" OR "outcomes" OR "advice" OR "success factors" OR "implement" OR "deploy*")

	String 4 ("Clinical Information System" OR "Hospital Information System" OR "Physician Office System" OR "Computer Physician Order Entry System") + ("change*" OR "risk*" OR "patient safety" OR "culture" OR "socio*") String 5 ("Electronic Patient Record" OR "Computer Provider Order Entry System" OR "Electronic Medical Record" OR "Continuity of Care Records") + ("change*" OR "risk*" OR "patient safety" OR "culture" OR "socio*") String 6 ("Health Information System" OR "Computerized Patient Record" OR "Electronic Medical Summary" OR "Electronic Health Record") + ("change*" OR "risk*" OR "patient safety" OR "culture" OR "socio*") String 7 ("Clinical Information System" OR "Hospital Information System" OR "Physician Office System" OR "Computer Physician Order Entry System") + ("technic*" OR "quantit*" OR "quality*" OR "econom*") String 8 ("Electronic Patient Record" OR "Computer Provider Order Entry System" OR "Electronic Medical Record" OR "Continuity of Care Records") + ("technic*" OR "quantit*" OR "quality*" OR "econom*") String 9 ("Health Information System" OR "Computerized Patient Record" OR "Electronic Medical Summary" OR "Electronic Health Record") + ("technic*" OR "quantit*" OR "quality*" OR "econom*")
With the exact phrase	No entry
With at least one of the words	"lessons" OR "outcomes" OR "advice" OR "success factors" OR "implement*" OR "deploy*" OR "change*" OR "risk*" OR "patient safety" OR "culture" OR "socio*" OR "technic*" OR "quantit*" OR "quality*" OR "econom*"
Without the words	No entry
Where my words occur	In the title of the article

Language	English
File format	Any
Date	2000 to 2007
Occurrences	“In the text of the page”
Domain	No entry
Usage Rights	Not filtered by license
SafeSearch	No filtering

Literature Review 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 Centre for Health Information Technology
American Family Physician	Physician Office System Program Alberta	Calgary Herald	College of Family Physicians of Canada
Archives of Family Medicine	British Columbia e-MS	Government Health IT	McMaster University COMPETE Program
Annals of Family Medicine	Physician Information Technology Office – British Columbia	Healthcare Informatics	Canadian College of Health Service Executives
Family Medicine	General Practice Computing Group - Australia	Canadian Healthcare Technology	Royal Australian College of General Practitioners
Journal of the American Medical Association	Health Canada	Healthcare IT News	Danish College of General Practitioners
Journal of the American Medical Informatics Association	Denmark - Medcom	Canadian EMR	Royal New Zealand College of General Practitioners
Health Informatics Journal	ONCHIT - US Department of Health and Human Services	The New Generalist	Royal College of General Practitioners
Computers in Nursing	National Institutes of Health	Health Informatics New Zealand	Health Research Council of New Zealand
Medical Informatics and the Internet in Medicine	Canada Health Infoway	Health Care and Informatics Review Online	
International Journal of Medical Informatics	British Columbia Medical Journal	Health Informatics Society of Australia	
The Internet Journal of Medical Informatics	MJA - Medical Journal of Australia	Healthelink - Australia	
Health Affairs	CMAJ - Canadian Medical Association Journal	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			

Appendix 2

Conformance and Certification Organizations Literature Review Search Data

Keywords and Alternate Phrases for Health Information Systems

Clinical Information System	Ambulatory Care System
Health Information System	Physician Office System
Computerized Patient Record	Electronic Patient Record
Electronic Health Record	Electronic Medical Record

Care Settings Search Terms

Primary Care
Ambulatory Care
General Practice
Family Practice

Countries

Canada	United States
Denmark	Australia
Sweden	New Zealand
United Kingdom	

Sources of Information

Literature Databases and Search Strings

MEDLINE

Search String	('Clinical Information System' OR 'Ambulatory Care System' OR 'Physician Office System' OR 'Electronic Patient Record' OR 'Health Information System' OR 'Computerized Patient Record' OR 'Electronic Medical Record' OR 'Electronic Health Record') AND ('certification' OR 'conformance' OR 'standards' OR 'interoperability' OR 'evaluate' OR 'assess' OR 'quality' OR 'testing')
ti:	As per the above search string
cp:	As per Table 3, manually searched
dp:	2005 to 2008, manually searched
lg:	English, manually searched
All other fields:	Unchecked

Actual MEDLINE search string: ((Clinical Information System or Ambulatory Care System or Physician Office System or Electronic Patient Record or Health Information System or Computerized Patient Record or Electronic Medical Record or Electronic

Health Record) and (certification or conformance or standards or interoperability or evaluate or assess or quality or testing)).ti

Additional search with no better results: (("health information exchange" or "health information network" or "electronic health record") and ("interoperability" or "certification" or "conformance"))

PUBMED

MeSH Concepts	"Clinical Information System" OR "Ambulatory Care System" OR "Physician Office System" OR "Electronic Patient Record" OR "Electronic Medical Record" OR "Health Information System" OR "Computerized Patient Record" OR "Electronic Health Record"
ANDed with	"certification" OR "conformance" OR "standards" OR "interoperability" OR "evaluate" OR "assess*" OR "quality"
All other fields	Visually examined

EMBASE

Search string	("Clinical Information System" OR "Ambulatory Care System" OR "Physician Office System" OR "Electronic Patient Record" OR "Electronic Medical Record" OR "Health Information System" OR "Computerized Patient Record" OR "Electronic Health Record") AND ("certification" OR "conformance" OR "standards" OR "interoperability" OR "evaluate" OR "assess*" OR "quality ")
ti:	As per above search string
cp:	As per Table 3, manually searched
dp:	2005 to 2008, manually searched
lg:	English, manually searched
All other fields:	Unchecked

The Cochrane Library

Record title	As per Table 1, search string is: ("Clinical Information System" OR "Ambulatory Care System" OR "Physician Office System" OR "Electronic Patient Record" OR "Electronic Medical Record" OR "Health Information System" OR "Computerized Patient Record" OR "Electronic Health Record") AND ("certification" OR "conformance" OR "standards" OR "interoperability" OR "evaluate" OR "assess" OR "quality ")
Restrict Search By Product	All of the Cochrane Library
Restrict Search By Record Status	All
Date Range	2005 to 2008

All other fields	Blank

Google Advanced Scholar Search Detail

With all the words	String 1 ("Clinical Information System" OR "Ambulatory Care System" OR "Physician Office System" OR "Electronic Patient Record") + ("certification" OR "conformance" OR "standards" OR "testing") String2 ("Electronic Medical Record" OR "Health Information System" OR "Computerized Patient Record" OR "Electronic Health Record") + ("certification" OR "conformance" OR "standards" OR "testing") String 3 ("Clinical Information System" OR "Ambulatory Care System " OR "Physician Office System" OR " Electronic Patient Record ") + ("interoperability" OR "evaluate" OR "assess" OR "quality") String 4 ("Electronic Medical Record" OR "Health Information System" OR "Computerized Patient Record" OR "Electronic Health Record") + ("interoperability" OR "evaluate" OR "assess" OR "quality")
With the exact phrase	No entry
With at least one of the words	“certification” OR “conformance” OR “standards” OR “interoperability” OR “evaluate” OR “assess” OR “quality “
Without the words	No entry
Where my words occur	In the title of the article
Language	English
File format	Any
Date	2005 to 2008
Occurrences	“In the text of the page”
Domain	No entry
Usage Rights	Not filtered by license
SafeSearch	No filtering

Conformance and certification organizations sources

Journal Websites	Government/Commissions Websites	Grey Sources	Colleges and Professional Associations
British Columbia Medical Journal	Certification Commission for Healthcare Information Technology	Government Health IT	American Academy of Family Practitioners Centre for Health Information Technology
Journal of the American Medical Informatics Association	Canadian Medical Association	Healthcare Informatics	College of Family Physicians of Canada

Health Informatics Journal	Physician Office System Program Alberta	Canadian Healthcare Technology	Canadian College of Health Service Executives
Computers in Nursing	British Columbia e-MS	Healthcare IT News	Royal Australian College of General Practitioners
Medical Informatics and the Internet in Medicine	Physician Information Technology Office – British Columbia	Canadian EMR	Danish College of General Practitioners
International Journal of Medical Informatics	Saskatchewan Medical Association	Health Informatics New Zealand	Royal New Zealand College of General Practitioners
The Internet Journal of Medical Informatics	Saskatchewan Health Information Network	Health Care and Informatics Review Online	Royal College of General Practitioners
Health Affairs	Manitoba Health – Physician Integrated Network	Health Informatics Society of Australia	Health Research Council of New Zealand
BMC Medical Informatics and Decision Making	Manitoba eHealth	Health Informatics Europe	Alberta Medical Association
Electronic Healthcare	General Practice Computing Group - Australia	OpenClinical	British Columbia Medical Association
Informatics in Primary Care	Denmark - Medcom	ePractice.eu	
	National Institutes of Health	Good-eHealth	
	The Swedish Council on Technology Assessment in Health Care	eHealth Impact	
	New Zealand Health Information Service	eHealth Insider	
	The National Board of Health and Welfare	World Health Organization	
	UK Health Informatics Society		
	NSW Dept of Health		
	Australia Department of Health		
	National e-Health Transition Authority (Australia)		
	Health Information Strategy Action Committee (New Zealand)		
	NHS Connecting for Health (UK)		

Appendix 3

Interview Guide: Suburban Physician Interviews

Interview Questions for Physician Interviews
Sherwood Park – Strathcona County PCN

Interviewee(s): ______________________________
Interviewer: ______________________________
Date: ______________________________

Interview Questions	Notes of Candidate's Answer	Interviewer's Guide to Answers
How long have you been in practice?		[Years or Months]
How many physicians are currently practicing in your office?		[Number]
How many non-physician clinicians do you employ?		[Number]
How many staff/admin do you employ?		[Number]
Are you the practice owner/key decision maker? If not, what is your role?		[Yes/No]. [If no, partner, contracted, part time]
How many patients do you typically see in a day?		[Number]
What is your target interview duration?		[Minutes]
What sort of health records system do you currently use?		[paper; electronic, but paper used to record notes first followed by transcription; electronic, desktop in exam room; electronic, laptop carried into exam room]
Can you describe the role your health information system plays when you are interviewing a patient		[take paper based notes as I go, take e-based notes as I go, don't take any notes in interview]
How long have you owned your EMR?		[Years or Months]
On a scale of 1 to 5, where 1 is poor and 5 is excellent, can you rate your computer skills (before and after the implementation)?		[1 to 5], [1 to 5]

When/where do you make your encounter notes?		[during interview in exam room, immediately after interview outside exam room door, at end of day either at the office or at home]
Prior to your current practice, what did you use for health information system to support your work?		[paper; electronic, but paper used to record notes first followed by transcription; electronic, desktop in exam room; electronic, laptop carried into exam room]
Can you describe the process you went through to buy your EMR? How did you gather market information?		[market scan, called vendors directly, talked to colleagues, talked to AMA/POSP/CPSA]
How did you select your EMR? What purchasing factors were most relevant to you?		[price, features, eligibility for financial support]
How did you install the EMR into your practice?		[big-bang, pilot, team-oriented integrative approach]
What do you use your EMR system for?		[Billing, scheduling, encounter note taking, lab results, order entry, contraindication management]
Where do you get your technical support?		[self, colleague, 3rd party]
What do you like/dislike about your current system?		
Did you notice a change in your patient volumes after your implementation? If so, can you say what %age it dropped to and for how long? Why?		[%, months]
On a scale of 1 to 5, where 1 is completely dissatisfied and 5 is extremely satisfied, what would you say your overall satisfaction is with your system?		[1 to 5]

Knowing what you know now, would you still have bought the EMR? Why do you say that?		[yes/no]

Interview Guide: Urban, hospital and academic physician interviews

Setting	Interview Questions	Notes of Candidate's Answer	Guide to Answers
All	How long have you been in practice?		[Years or Months]
All	How many physicians do you have in your team/group?		[Number]
All	Please describe the role and number of members of your team (ie: non-physician clinicians, admin staff)		[Role, Number]
All	Are you the physician leader of the group? If not, what is your role?		[Yes/No]. [If no, role?]
All	How many patients do you typically see an hour?		[patients / hour]
Hospital	How much time is spent face-to-face with each patient?		[Minutes]
Clinic	How much time do you typically book per patient?		[Minutes]
All	For every hour of time spent seeing patients, how much time is spent on paper work (work generated by patient, lab, letters, billing, etc)		[Minutes]
All	What sort of health records system do you currently use?		[paper; electronic/paperless, both (please describe if both)]
Clinic	[If answer to above question is paperless or both] Please describe the process you went through to buy your system		[market scan, called vendors directly, talked to colleagues, talked to medical association]

All	What impact has the EMR had on how you interact with the patient? How, if at all, have you dealt with it?		[eye contact, body language, body positioning, urgency]
All	Have you used an EMR, and if so, for how long?		[Yes/No] [Years or Months]
All	How comfortable are you with using an EMR? 1. Extremely uncomfortable 2. Some discomfort 3. Some comfort 4. Comfortable 5. Seamlessly integrated in workflow		[1 to 5] Why?
All	When/where do you make your patient encounter notes?		[In hospital, at station, bedside] [In clinic, in exam room, out of exam room, both] [At home, remote connect]
All	Have you used any other electronic systems prior to the one you are currently using? If yes, what?		[paper; electronic, but paper used to record notes first followed by transcription; electronic, desktop in exam room; electronic, laptop carried into exam room]
Clinic	How did you select your EMR? What purchasing factors were most relevant to you?		[price, features, eligibility for financial support, familiarity]
Clinic	How did you implement the EMR into your practice?		[big-bang, pilot, team-oriented integrative approach]

All	What do you use your EMR system for? Check all that apply	☐ Billing ☐ Scheduling ☐ encounter note taking ☐ lab results ☐ Consults ☐ Practice quality assurance (i.e. audits) ☐ Follow-up Reminders (i.e. repeat pap smear due, etc) ☐ order entry ☐ contraindication management	[Billing, scheduling, encounter note taking, lab results, order entry, contraindication management]
Clinic	Where do you get your technical support?		[self, vendor, admin, colleague, 3rd party]
All	What do you like/dislike about your current system?		
All	How does your EMR impact your patient volumes?	☐ Increased it ☐ Decreased it ☐ Same as prior ☐ Estimated percentage change:____	
All	On a scale of 1 to 5, where 1 is completely dissatisfied and 5 is extremely satisfied, what would you say your overall satisfaction is with your system?		[1 to 5][If 1 or 5, please explain]
Clinic	Knowing what you know now, would you still buy this EMR? Why do you say that?		[yes/no]

Appendix 4

Teledermatology Data gathering Tools

Interview Questions for Patient Interviews

Interviewer: ______________________________
Date: ______________________________

Interview Questions	**Notes of Candidate's Answer**	
1. Did your physician tell you that you were being referred to a Teledermatology Clinic?		[Yes / No]
2. Did you know what a teledermatology clinic is?		[Yes / No]
3. Were you aware of what was going to be happening at this appointment?		[Yes /No]
4. Did you have any expectations about what type doctor you would see during this visit?		[Yes/No] [expected dermatologist]
5. Have you ever seen a specialist before? How does this appointment compare to other previous specialist appointments?		[Yes/No]
6. Do you have any reservations about the clinic, how it was run, or the technology used in the clinic?		[Yes/No]
7. Were you told when you would hear about the results of today's appointment?		[Yes/No]
8. Are you satisfied that your needs are being met with this teledermatology experience?		[Satisfied, dissatisfied, inconsequential]

Interview Questions for Referring Physician Interviews

Interviewer: ______________________________
Date: ______________________________

Interview Questions	Notes of Candidate's Answer	Interviewer's Guide to Answers
How often do you refer a patient to a specialist for advanced assessment and care?		[every month, every two months, every quarter, every half year]
How often do you refer a patient to a dermatologist for advanced assessment and care?		every month, every two months, every quarter, every half year]
When you refer patients to a specialist, do you typically send patients to the same specialists?		[habitually sends patients to same specialists, refers to specialists based on availability, no set pattern]
When you refer patients to a dermatologist, do you typically send patients to the same dermatologist?		[habitually sends patients to same dermatologist, refers to dermatologist based on availability, no set pattern]
Can you describe the process you and your staff must go through to make a referral to a specialist?		[workflow description]
Can you describe the process you and your staff must go through to make a referral to the Teledermatology Clinic?		[workflow description]
Please describe the information you traditionally receive back from a specialist once they have seen your patient		[No info, Text report, images]
Thinking about the Teledermatology Clinic and your experience referring patients to it, can you describe your level of satisfaction with the clinic and why.		[Unsatisfied to satisfied, why]

The Teledermatology equipment is simple and the referral process easy. Would you consider doing this yourself? Why?		They might want to, but they might like the convenience of not having to worry about it
Were you satisfied with the nature, amount and timeliness of patient reports/feedback from the Teledermatology Clinic?		

Interview Questions for Dermatologist Interviews

Sherwood Park – Strathcona County PCN

Interviewer: ______________________________
Date: ______________________________

Interview Questions	Notes of Candidate's Answer	Interviewer's Guide to Answers
How long have you been conducting dermatological assessments using telemedicine technology?		Years or Months]
What would you say are the main reasons why physicians refer their patients to see you through this method?		[Reasons]
What would you say are the main strengths of this system?		[Strengths, saves time, for pt, saves time for physicians]
What are the main barriers for this approach to care?		[costs of system, physician scepticism]
Can you comment on your experience working with the Sherwood Park PCN using Teledermatology? What went well? What did not go well?		
Can you comment on how you might improve the delivery of care through this mode?		
Can you comment on the role that images and image quality play in the diagnosis and intervention? How does it compare against the notes? Why?		
Do you get paid FFS for your consults via ConsultDerm?		

Can you confirm that you were interested in turning around ConsultDerm referrals in 48 hours?		
Do you have any references that would quote a typical wait/turnaround time for referrals? I'd like to see if we can conclusively say we are faster.		

Non-referring physicians email survey

Dear physician:

Our PCN is planning to publish an academic paper that reviews the PCN's Teledermatology Clinic. We have gathered data from patients and referring physicians regarding the Clinic but have not gathered information from physicians who have not referred to the clinic.

You are receiving this email because we believe to this point you or your clinic have not made referrals to the Teledermatology Clinic.

To help us learn more about why physicians refer or choose not to refer, can you tell us why you have not yet referred to the Teledermatology Clinic? Please simply respond by indicating the letter of the response that best fits your thoughts. You can indicate more than one letter if you have more than one reason.

A. Actually, I have recently referred to the Clinic
B. You didn't know the PCN had a Teledermatology Clinic
C. You know about the Clinic but you don't know how to refer to it
D. You do not have dermatology patients in your practice
E. You take care of your dermatology patients yourself
F. You are satisfied with the service of the dermatology specialist you currently refer to and see no reason for change
G. Referring to the PCN Teledermatology Clinic is more difficult than referring to your preferred specialist
H. You have concerns over the liability implications of relying on remote diagnoses
I. You do not believe that accuracy of remote diagnoses is comparable to in-person diagnoses
J. Other:____

Thank you

Appendix 5

Self-service appointment scheduling study data gathering tools

Patient Experience Survey

Thank you for taking the time to complete this short survey. Your agreement to participate in the study is completely anonymous and will have no bearing on the care you receive from Dr. Adams. We will not ask for your name in the survey. By returning this survey, you permit us to use this data in an anonymous and aggregated fashion for our study. When our study is reported, the data will be collected and only aggregate results will be reported.

Please complete the survey and return it to the Sherwood Park PCN in the self addressed and stamped envelope provided.

Thank you

1. Are you a patient of Dr. Jim Adams?
   - ☐ Yes, I am a patient.
   - ☐ No, I am not a patient.

   If you are not a patient, you do not need to complete the rest of this survey.

   Please discard the survey. Sorry for troubling you.

2. Do you know that Dr. Jim Adams has a website where his patients can book appointments to see him, without calling his office?
   - ☐ Yes, I am aware of Dr. Adams' online appointment booking website.
   - ☐ No, I am not aware of the online appointment booking website. **(If you are not aware, please go to Question 19)**

3. How did you find out about the opportunity to book your appointments online with your physician? (Please select one)
   - ☐ My physician told me
   - ☐ My physician's staff told me
   - ☐ An acquaintance of mine told me
   - ☐ I saw a poster while in his office
   - ☐ I saw his small yellow leaflet
   - ☐ Other: ______________________

4. Have you booked an appointment with Dr. Adams by using his online appointment booking service?

- ☐ Yes, I have actually used the online booking service to make an appointment to see Dr. Adams. **Please go to Question 7**
- ☐ No, I have not successfully booked an appointment. **Continue to Question 5**

5. Can you tell us a little about why you have not actually booked an appointment with Dr. Adams through his online booking service? Check all that apply

- ☐ I would like to book online, but I don't know how to do it.
- ☐ I am concerned about my privacy and I do not trust the security of a website
- ☐ I tried to book an appointment online, but I could not navigate to the website
- ☐ I tried to book an appointment online, but I had trouble entering my telephone number
- ☐ I tried to book an appointment online, but I had trouble entering my healthcare number
- ☐ I tried to book an appointment online, but the website told me I was not a patient of Dr. Adams
- ☐ I tried to book an appointment online, but the appointments were too far into the future
- ☐ Other:

____
____
____
____

6. If the problems you indicated in the above question were resolved, would you consider booking an appointment through the online booking system?

- ☐ No, I would still not book online. Can you tell us why?___________________________
  ____
  ____
  ____
  ____
- ☐ I might, but I have other problems I would need to see fixed. Please tell us more:
  ____
  ____
  ____
  ____
- ☐ Yes, I would consider booking online again.

Once you have answered Question 6, please go to Question 19

Question 7:

7. Have you responded to a similar survey about Dr. Adams' online booking system in the recent past?

- ☐ I received the previous survey, completed it and returned it. **Thank you. We have a few more questions for you. Please go to Question 24 to complete the survey and return it to us.**
- ☐ I received the previous survey, but I did not return it. **Please continue to Question 8.**
- ☐ I did not receive the survey. **Please continue to Question 8**

8. You are a patient who has booked an appointment with Dr. Adams online. Please indicate how easy it was to navigate to the online appointment booking website. (Please select one)

- ☐ It was very easy to get there. I got there on my first try
- ☐ I had trouble with the website address. Once I had the right address, it was easy
- ☐ I had some problems. Please describe the problems you had:

____
____
____
____
____
____
____

9. Once you had arrived at the online appointment booking website, please indicate how easy it was to use the site (Please select one):

- ☐ Once I got there, the site was very easy to use
- ☐ Once I got there, the site was moderately easy to use
- ☐ Even after I got there, I found the site difficult to use. Please indicate why?

____
____
____
____
____

10. Compared to booking your appointment by calling your physician's office, how easy was the online appointment booking website (Please select one)?

- ☐ Booking online is easier
- ☐ Both methods are the same
- ☐ Booking online is harder. Why?

____
____
____
____
____
____

11. Why did you choose to book your appointment through your physician's online appointment booking website? (Check all that apply)
- ☐ I thought it would be more convenient
- ☐ I thought it offered more privacy
- ☐ His telephones are always busy
- ☐ I prefer to do things myself
- ☐ Other:

____
____
____

12. Did you have any concerns about booking your appointment online when you first decided to book through this method?
- ☐ No concerns
- ☐ Yes. Please describe:

____
____
____
____
____
____

13. Did you receive a reminder email prior to your appointment?
- ☐ Yes
- ☐ No

14. Please indicate your overall satisfaction with your physicians' online appointment booking website?
- ☐ Extremely satisfied
- ☐ Satisfied
- ☐ Dissatisfied
- ☐ Extremely dissatisfied

15. What did you like best about booking your appointment online?

____
____
____
____
____

16. What did you like the least about booking your appointment online?

____
____
____

17. Would you book an appointment with your physician using his online appointment booking website in the future?
- ☐ Yes
- ☐ No

18. If your physician could make your health information (such as health history, lab test results, diagnoses, etc) available to you at a highly secure website, would you be interested in using that site?
- ☐ Yes
- ☐ Maybe, but I would have some concerns
- ☐ No

If you answered “Maybe” or “No”, please indicate Why:

____
____
____
____
____

Question 19:

19. How frequently do you use the internet (Please select one):
- ☐ Several times a day
- ☐ Once a day
- ☐ Once per week
- ☐ Once per month
- ☐ Every 3 months
- ☐ Very rarely
- ☐ Never

20. Please select all of the tasks which you routinely complete using the internet. (Check all that apply)

- ☐ Banking and/or bill payment
- ☐ Reading the news or playing games
- ☐ Making purchases
- ☐ Completing my personal taxes
- ☐ Searching/surfing the web
- ☐ Email
- ☐ Other:___________________________

21. Can you tell us a little about your computer skills?
- ☐ I am a novice computer user
- ☐ I am new to computers but have some experience with them
- ☐ I consider myself to be an average computer user
- ☐ My skills are better than average
- ☐ I am an expert computer user

22. Could you please indicate your age range?
- ☐ 0 – 20 years old
- ☐ 21 to 30 years old
- ☐ 31 to 40 years old
- ☐ 41 to 50 years old
- ☐ 51 to 60 years old
- ☐ 61 to 70 years old
- ☐ 70 years and older

23. Please indicate your gender
- ☐ Female
- ☐ Male

Question 24:

24. Please indicate your highest level of education

- ☐ Some high school
- ☐ High school diploma
- ☐ Some college or university
- ☐ College diploma
- ☐ University degree

25. Can you tell us how long you have been a patient of Dr. Adams'

- ☐ Less than 1 year
- ☐ 1 to 2 years
- ☐ 2 to 5 years
- ☐ 5 to 10 years
- ☐ 10 to 15 years
- ☐ 15 to 20 years
- ☐ 20 to 25 years
- ☐ 25 years or more

Thank you for completing this survey. Your responses will help us to understand more about how online appointment scheduling systems can help other patients in the future.

Please use the self-addressed and stamped envelope that was included in your package to return this survey to the address below:

Sherwood Park PCN
Suite 105 – 80 Chippewa Road
Sherwood Park, AB
T8H 1Z3

Thank you
Dave Ludwick
General Manager