TECHNOLOGY SOLUTIONS IN HEALTH CARE DELIVERY: THE COMPUTER-BASED PATIENT RECORD

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Abstract

The objective of this paper is to look at the benefits of the adoption of computer-based patient records and to formulate recommendations that assist in overcoming identified barriers to implementation.

The benefits and barriers associated with the wide spread adoption of computer-based patient records systems in the North American marketplace are investigated. The clinical, workflow, administrative and revenue benefit of computer-based patient records are discussed in relation to the currently used paper-based system. Significant barriers to implementation are identified and recommendations as to how to overcome those barriers are presented.

The business case for the adoption of computer-based patient records is made through the use of case studies of successful implementations and return on investment and payback period calculations.

Keywords: Computer-based patient record; Health information technology; Health information exchange, Electronic medical record; Electronic Health Record; HITECH Act; Health care reform

Executive Summary

Computer-based patient records (CPR) represent a significant improvement over the paper-based records widely used in North America at present. The potential for cost reductions and health care service improvements through the use of CPRs has been identified by the governments of Canada and the United States. As a result, both of these governments have made significant financial commitments to the development of CPR systems (CPRSs). As part of the American Recovery and Reinvestment Act (ARRA) in the United States more than US$32 billion has been committed to promote the adoption of CPRS by physicians. In Canada, Canada Health *Infoway* leads the push for CPRs implementation. The Canadian Federal Government has committed a total of Cdn$1.5 billion, including Cdn$500 million as part of the 2009 Economic Action Plan, to the work of *Infoway*. The current level of financial support for the adoption of CPRSs is at an all-time high and the current political climate in North America is primed for significant reforms in health care. Together these drivers make it the right time to move forward in the implementation of wide-spread CPRSs.

The benefits of the adoption of a CPRS can be categorized in four silos: Clinical benefits, workflow benefits, administrative benefits and revenue benefits. The benefits that can be expected in each of these areas are:

Clinical Benefits:

1. Complete, up-to-date patient records
2. Improved organization and legibility of patient records
3. Improve decision making, improved disease management
4. Increase patient safety

Workflow Benefits:

1. Improve data intake
2. Ability to support multiple users
3. Reduction in the need for support staff
4. Reduction in the use of transcription services
5. Improve staff communication
6. Improved management of referrals, laboratory results, prescriptions and drug recalls

Administrative Benefits:

1. Improve physician performance monitoring
2. Research support
3. Improve coding and insurance reimbursement
4. Improved patient information security

Revenue Benefits:

1. Increase in maintenance visits
2. Improved coding
3. Improved cash flow

The barriers to the adoption of CPRSs can be categorized as being related to a technical barrier, a human factor barrier or a financial barrier.

The technical barriers are related to the need for interoperability and a standardized medical vocabulary as well as issues regarding data security. The recommendations for overcoming these technical barriers are:

Interoperability and vocabulary

1. Defer the decision on what CPRS to implement until the US Department of Health and Human Services announces its certification criteria for interoperability standards
2. Select SNOMED-CT as a standard medical vocabulary

Data security

1. Choose a system that uses data security protocols equivalent to those used in the financial sector
2. Use a system access application that uses practitioner's access card and password security
3. Single portal access to entire CPRS
4. Patient must authorize all access to their data

The barriers related to human factors focus upon two groups, patients and health care workers. The recommendations to overcome those barriers follow.

Patients

1. Educate the public as to the security of CPRSs and the benefits of adoption
2. Develop a patient-centric CPRS that allows patients to take ownership of their health

Health care workers

1. Identify and support CPRS champions
2. Institute a phased roll-out of a CPRS with sufficient training
3. Adopt a modular CPRS that presents a familiar computer interface

The recommendations for overcoming the barriers to adoption related to finances work to reduce and diffuse costs. The recommendations to overcome cost barriers are:

1. Adopt a modular CPRS that uses applications from various vendors to minimize development costs

2. Create Regional Health Information Exchanges that act as a central store house of patient information

It has been demonstrated that the payback period for a CPRS system can be between 13 and 30 months without direct financial support from government sources. The quantitative and qualitative benefits of the implementation of CPRSs are significant.

Three health care reforms, specifically changes to physician pay structures, workflow reengineering and customer engagement, will force the health care industry to implement CPRS not only because there is a solid business case for the adoption, but because a CPRS will be looked at as an essential tool for a modern health care practice.

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Glossary

Clinical Data Repository (CDR)	A data base that houses patient data from a clinical setting. Equivalent to a HIE.
Computer-based Patient Record (CPR)	The individual record of a single patient's health information stored digitally. Additional terms use in the literature that are equivalent are: Computerized Medical Record (CMR), Electronic Health Record (EHR); Electronic Medical Record (EMR); Electronic Patient Record (EPR); Lifetime Data Repository (LDR); Virtual Health Record (VHR); Automated Medical Record (AMR)
Computer-based Patient Record System (CPRS)	Computer-based systems for input, storage, display, retrieval, and printing of information contained in a patient's medical record.
Health Information Technology (HIT)	Information technology used in the health care industry to digitize patient information and record results from radiology, laboratory and other sources
Health Information Exchange (HIE)	A data base that houses patient data from a clinical setting.
Data Production Modules	Applications used for health information input or connected medical devices that produce data for the CPR
Patient Medical Record	Physical collection of medical information belonging to an individual patient

List of Abbreviations

HHS	United States Department of Health and Human Services
ANSI-HITSP	American National Standards Institute-Healthcare Information Technology Standards Panel
CPRI	Computer-based Patient Record Institute
AMIA	American Medical Informatics Association
ANSI	American National Standards Institute
HIMSS	Healthcare Information and Management Systems Society
DPM	Data Production Modules
GP	General Practitioner, also known as a family doctor
IT	Information technology
HIMSS-EHRA	HIMSS Electronic Health Record Association
CMA	Canadian Medical Association
CMAH	The holding company for the Canadian Medical Association
ARRA	American recovery and reinvestment act, 2009
HITECH Act	Portion of the ARRA that deals with investment in computer-based patient record systems
CCHIT	Certification Commission for Healthcare Information Technology
DoD	United States Department of Defense
VHA	United States Veterans Health Administration
eHI	eHealth Initiative
ROI	Return on Investment
P4P	pay for performance
CPR	Computer-based Patient Record
HIT	Health Information technology
HIE	Health Information exchange
CPRS	Computer-based patient record system

1: Introduction

In North America one can travel to the top of a mountain and connect to their bank account through a cell phone. However, the same person can suffer from a disease that requires a second opinion and when they arrive for the appointment the physician has no information beyond the patient's name. This is an all too common occurrence in North America and is the type of issue that can be eliminated with the implementation of a computer-based patient record system.

This paper looks at the barriers to the wide spread adoption of computer-based patient record systems in the North American health care industry. Additionally, there are a number of recommendations that endeavour to guide the implementation of a computer-based patient record system.

A computer-based patient record is not simply a replacement for the traditional paper-based medical record, but a system that integrates all relevant health information in a single unit, and includes additional information, such as insurance billing information, that cannot be found in the paper-based file.

As will be illustrated not only is there a solid financial case for the adoption of computer-based patient record systems, but there is also a moral obligation to do better for patients.

Scope of Report

This paper will look at the history and short comings of the traditional paper-based patient medical record in Section Two. Following the review of the patient medical report

Section Three will focus on the volatile area of the health information technology industry and the initiatives currently driving the industry forward. Section Four focuses on the history and architecture of the computer-based patient record, including standards and the benefits computer-based records have over paper-based patient records. The barriers to computer-based patient record system implementation and recommendations to overcome those barriers are covered in Sections Five through Seven. Section Five covers technical issues, Section Six looks at the human factors and Section Seven looks at the financial impact of computer-based patient records. In Section Eight the business case for the adoption of computer-based patient record systems is made with a look at the results of implementations in large and small scale practices. The need for health care reform as a stimulus for the adoption of computer-based patient record systems is also addressed in Section Eight.

2: The Development of the Patient Medical Record

The patient medical record has a long history. In the fifth century BC Hippocrates, a Greek physician born in 460 BC who is known as the "father of medicine", advocated medical records fulfil two purposes as follows (Bemmel & Musen, 1997).

1. Accurately reflect the course of disease
2. Indicate the possible cause of disease

Since then the patient medical record has grown to encompass not only the notes of a physician or specialist, but also information from other sources such as laboratory test results, or radiological reports. However, presently patient medical records are often incomplete as they lack the actual radiological films or other non-alphanumeric data that must be accessed separately.

Hippocrates recorded the description of the disease as told by the patient and the patient's relatives in chronological order, creating a time-oriented medical record. With the advent of new technologies, such as the stethoscope and ophthalmoscope, in the early 19th century the patient record expanded to include the diagnostic findings of the medical professionals. In 1907 the Mayo Clinic in Rochester, Minnesota introduced a separate file for each patient; this was the origin of the patient-centred medical record (Bemmel & Musen, 1997). It was not until 1920 that the Mayo Clinic management instituted a standardized set of data that all physicians were compelled to record. These standards became the framework for the present day medical record. In the 1960's problem-oriented medical record were introduced, this resulted in improved patient chart organization. Notes were recorded per problem in the SOAP structure, which stands for subjective (S, the complaints of the patient), objective (O, the findings of the medical

professionals), assessment (A, test results and diagnosis) and plan (P, treatment). Alternatively, the notes in a problem-oriented medical record can be documented according to the DAO guideline: data (D, objective and subjective observations as well as test results), action (A, interventions prescribed by medical professionals) and outcome (O, result of interventions).

Most modern patient medical records are a combination of time and problem-oriented, however, due to the delay between office visits and the associated notes and the results of tests ordered the record is generally ordered by the source of the information, such as chart notes, x-ray results, laboratory tests, with each type of information in a separate section of the record.

The patient medical record has changed little since the standardization of the 1960's. Whereas the amount and type of information contained in the record has grown quickly over the past 40 years.

With the development of the medical system, specifically the increase in the number of specialists a patient may see and the increase in the number of different specialized tests and treatments a patient may undergo, the paper based medical record has become inadequate. This increase in the number of medical professionals accessing and adding to the patient medical record has increased the likelihood that an important piece of information or test result may not be in the record when they are needed. It has been found that in 81% of clinical encounters there was missing information that was needed at the time of the visit when using paper based patient medical records (Joyce & J McNeil, 2006). Further, it has been demonstrated that the use of computerized records systems decreases the incidence of medication error (HIMSS, 2009).

Paper based patient medical records suffer from the limitations of being physical; they can be in only one place at a time. This precludes more than one professional from working with a patient record at any one time, and creates the situation where there can be numerous,

incomplete patient records at different specialists or in the case of individual who do not have a general practitioner (GP) any number of incomplete records at drop-in medical clinics. This phenomenon of multiple records, covering only a single patient doctor encounter, can become a major problem that compromises the continuity and quality of care available to patients as the number of individuals with a regular GP decreases (Joyce & McNeil, 2006).

In addition to the likelihood that a physical record is incomplete and only available to one person at a time there is also the realty that personal medical records get lost or misplaced. This leads to a large waste of time for staff and can be harmful to patients in the case of emergency.

An additional problem with the use of paper based medical records is the difficulty associated with poor or illegible handwriting of notes. To avoid this issue some offices employ transcriptionists to type physicians' notes. This dictation and transcription increases costs, adds another stop for the medical record to pass through and introduces another opportunity for errors.

Advances in medicine such as the digitization of radiology images and computer based physiological testing such as electrocardiograms limits the amount of information that is able to be in the medical record, and creates a parallel digital record of results.

Paper based records also present difficulty for researchers and medical personnel looking at trend analysis. It is extremely slow and has high resource intensity to data mine paper based records to conduct research or for trend analysis. This could lead to delays in trend identification and limits the ability of researchers to conduct valuable medical studies.

Security and privacy issues are vital in the medical industry. Paper based patient medical records have no built in security measures and there are no enforceable record tracking systems that allow the movement of the record to be accurately monitored or reviewed at a later time.

The lack of a history of record access is a significant possible source of weakness for patient privacy and record security.

Most paper based patient record lack the capacity to correlate medical information with insurance billing information. This results in the delay in billing and possible loss of revenue for medical clinics. The personnel costs to manually do the billing for each patient encounter are a significant cost that diminishes the net income of the practice.

Many of the short comings of the paper-based patient record can be solved through the use of a computer-based system. However, the health care industry in North America has been slow to adopt this technology for a number of reasons that will be covered throughout this paper.

3: Health Information Technology (HIT)

Information technology (IT) has changed how people live their lives. It has changed how people communicate and how they interact. Information technology has created a world where there is more information created and available than can possibly be consumed. It is estimated that by the year 2010 there will be 988 Exabyte (one Exabyte is a billion gigabytes) of data stored digitally around the world (Mearian, 2007). A comparison of the volume of information this represents can be done using the holdings of the United States Library of Congress. The Library of Congress has 130 million holdings with a total amount of information equivalent to 10 terabytes (10,000 gigabytes) so the collected holdings would represent 0.000001% of the total data available in the world. It is only with the use of technology that this amount of information could be created, stored, and most importantly be dealt with.

3.1 Industry

The HIMSS Electronic Health Record Association (EHRA) is an international trade association of health information technology (HIT) companies, addressing integrated efforts to create interoperable HIT systems in hospital and ambulatory care settings. The EHRA has a membership of over 40 HIT companies and member organizations account for more than 90% of all installed HIT systems in the United States (HIMSS EMRA, 2009). Members of the EMRA are listed in Table 3.1.

Table 3.1:EMRA member vendors operating in North America

AllMeds	Healthland
AllScripts	Healthport
Amazing Charts	HMS
BlueWare	IBM
Capmed	Initiate
Chartcare	McKesson
ChartMaker	MedHost
CPSI	Medinformatrix
Digichart	MediNotes
DigitalMD	Mediserve
Doctations	Meditech
eClinicalWorks	Noteworthy
Eclipsys	Quadramed
e-MDS	Sage
EPIC	Siemens
General Electric Healthcare	Springcharts
Glostream	Suncoast solutions
Greenway	Workflow.com
	Xpress

NOTE: An up to date list of leading HIT firms, along with product descriptions can be found at: http://www.providersedge.com/ehr_links_products_services.htm

In addition to these companies large firms such as Microsoft (Microsoft HealthVault, 2009) and Google (Google, 2009) have, in recent years, introduced patient focused health records. Additionally, Microsoft has introduced a software solution called Amalga (Amalga, 2009) marketed to hospital and large health provider groups for use on enterprise HIT systems.

Based on a study, of 2952 member hospitals of the American Hospital Association published in the New England Journal of Medicine in April of 2009, only 1.5% of US hospitals have a comprehensive HIT system, and an additional 7.6% have a basic system (present in at least one clinical unit) (Jha, et al., 2009). The size of the hospital had a significant effect on the

likelihood of any HIT system being in use, as is reflected in Table 3.2. Larger hospitals, those located in urban areas and teaching hospitals were more likely to have HIT systems.

Table 3.2: Adoption of Comprehensive and Basic Systems According to Hospital Characteristics

Size	**Comprehensive**	**Basic**	**No System**
Small (6-99 beds)	1.2	4.9	93.9
Medium (100-399 beds)	1.7	8.1	90.2
Large (+400 beds)	2.6	15.9	81.5
Region			
Northeast	1.1	8.9	90.1
Midwest	1.7	6.6	91.7
South	1.4	7.3	91.3
West	1.9	7	91.1
Profitability Status			
For-profit	1.3	5.2	93.5
Private non-profit	1.5	8.4	90.1
Public	1.7	5.8	92.4
Teaching Status			
Major teaching	2.6	18.5	78.9
Minor Teaching	2.4	10.6	87
Nonteaching	1.3	5.6	93.1
Member of hospital system			
Yes	2.1	8.4	89.5
No	1.1	6.3	92.6
Location			
Urban	1.9	8.4	89.7
Nonurban	0.6	4	95.3

Table created by author with data from Source: (Jha, et al., 2009)

3.2 HIT Initiatives

The use of IT in the health care industry represents an opportunity to better serve patients and create a more efficient, effective health care system. The well-managed integration of IT into the delivery of health care can lead to many benefits. These benefits include improved quality of care and patient safety; increased efficiencies through better access to health care, particularly for those living in rural and remote locations and those with limited mobility (e-homecare); flexibility for physicians to devote more time to their core competencies of providing direct patient care and less to administrative and clinical management tasks; and improved patient satisfaction, in terms of both access and outcomes

In both the United States and Canada there are many initiatives aimed at integrating IT into the health care delivery system. HIT is a priority for the medical community and government as the need for health care reform is felt throughout North America. For this reason there is much work being done in the area, and at this point it is still unclear what organizations will ultimately be responsible for the governance of the HIT industry in North America.

3.2.1 Canada

In Canada, the Commission on the Future of Health Care in Canada: The Romanow Commission (Romanow, 2002) can be identified as the initial stimulus for the development of the HIT industry. The Federal government has made a commitment to support the development of the HIT industry and works with a number of organizations to develop HIT solutions for the industry. Much of the direct support provided by the federal government is focused on funding

of Canada Health *Infoway*. This funding includes Cdn$400 million allocated in the 2007 federal budget and an additional Cdn$500 million allocated as part of the Economic Action Plan in 2009 (Office of the Honourable Leona Aglukkaq, Federal Minister of Health, 2009). In addition to *Infoway* the Canadian Medical Association and the Canadian Institute for Health Information also have significant role in the development of HIT in Canada.

Canadian Medical Association (CMA)

The Canadian Medical Association (CMA) has a clear HIT vision:

Optimize the use of information and communication technology in the service of health and health care, for CMA members, for all Canadian physicians and for the people of Canada. (CMA, 2002)

The CMA and CMA Holdings Incorporated (CMAH), the holding company for the CMA, developed a comprehensive e-health strategy in 2002. The strategy was developed in conjunction with the membership of the CMA and HIT committee. The strategy maps out recommended activities in a number of key areas:

- developing policy frameworks for IT in such areas as privacy, financing, remuneration, licensure and liability
- building strong partnerships with government and government agencies, other health care organizations, industry and key stakeholders
- working to ensure provider engagement, consistent change management frameworks and knowledge sharing and development

- managing processes such as workflow, benefits and cost analysis and decision support tool functionality
- developing information and communications technology (ICT) solutions (such as standards for interoperability, value for physicians, rural and remote communications and e-homecare solutions)

The activities that are being pursued by the CMA as part of the e-strategy can be grouped into internal initiatives to support specific needs of members and external initiatives to influence the integration of information technology into the health care system to better support the requirements of physicians (CMA, 2002).

Canada Health *Infoway* (*Infoway*)

Canada Health *Infoway* (*Infoway*) is a not-for-profit organization funded by the Canadian federal government. *Infoway* was established by Canada's First Ministers when they agreed in 2001 "to work together to strengthen a Canada-wide HIT to improve quality, access and timeliness of health care for Canadians." The 14 federal, provincial and territorial Deputy Ministers of Health are the Members of the Corporation.

Infoway has focused on the creation and adoption of electronic medical records (EMRs) with the goal of creating a health care system that can deliver better health care for all Canadians (Canada Health Infoway, 2008).

Better access to information will enable clinicians to:

- Devote more time to patients
- Improve patient safety (Up to 24,000 Canadians die every year due to adverse events)

- Deliver more efficient care, leading to lower costs and shorter wait times

Infoway believes the creation of a network of EMR systems will usher Canada's health care system into the 21st century, bringing new ways of working with patients and their health information including:

Patient-centred care. Patient-centred care means you become more directly involved with your caregivers, sharing information and working together to make decisions that are right for you.

Collaborative teams. According to your needs, a team of caregivers from different disciplines – for example, doctors, pharmacists and nurses – collaborate to provide the best possible care.

Evidence-based care. Evidence-based care means caregivers make decisions about your care based on current, relevant case studies and evidence gathered from experts around the world.

Redesigned business processes. New ways of gathering and sharing information will lead to better business processes that support evidence-based, collaborative care.

Relevant data capture and analysis. A pan-Canadian EMR network built on secure databases will make it easier to collect and analyze Canadians' health information.

Timely feedback and education. An EMR network provides caregivers with timely feedback and education. This feedback loop will result in better informed, more accessible and efficient health care.

Infoway believes the use of EMRs will create a new way to provide health care in Canada where teams of clinicians share information and work together to ensure the patients well being.

Canadian Institute for Health Information (CIHI)

A second not-for-profit organization involved in HIT in Canada is the Canadian Institute for Health Information (CIHI). CIHI provides essential data and analysis on Canada's health system and the health of Canadians. CIHI works with *Infoway* to establish the health infostructure standards for HIT in Canada.

Health infostructure standards are documented agreements containing technical specifications or precise criteria to facilitate the interoperability of communication and IT in support of improved service delivery and informed decision-making in health (Canadian Institute for Health Information, 2009).

The advantages of developing standards for EMRs are:

- Minimizing costs as they relate to initial design and development;
- supporting re-use and replication of components
- application integration and interoperability
- systems integration

3.2.2 United States

There are numerous initiatives and organizations involved in the development of HIT in the United States. The beginning of the HIT industry as it relates to health information sharing can be traced to the 1991 report "Computer-based Patient Records: An Essential Technology for Health Care" issued by the Institute of Medicine (Dick, 1991). An Executive Order issued by President George W. Bush in 2004 that created the Office of the National Coordinator of HIT can also be identified as a significant landmark in the development of the HIT industry in the United States. The most recent significant driver of HIT in the US has been the allocation of

funding as part of the American Recovery and Reinvestment Act of 2009. As there is currently significant financial support for the development of HIT in the US there is also a great number of different organizations who are working to stake their claim as influential governing bodies in this fast growing sector.

HITECH Act

As part of the American Recovery and Reinvestment Act of 2009 (ARRA) (111th Congress of the United States of America, 2009) US$31.2 billion is designated for health care infrastructure. An expected savings of US$12 billion over a ten year period results in a net investment of US$19.2 billion. This funding is designated to be used to increase the use of EMRs by physicians and hospitals; this portion of the bill is called, the Health Information Technology for Economic and Clinical Health Act, or HITECH Act (111th Congress of the United States of America, 2009, pp. 112-165, 353-398).

The investment is being administered through the U.S. Department of Health and Human Services (HHS) with the goal of modernizing the health care system by promoting and expanding the adoption of health information technology by 2014. The key requirement to seek a grant through this program is a system must be capable of "meaningful use". The definition of "meaningful use" was issued on June 16, 2009 (Meaningful Use Workgroup- Health IT Policy Committee, June 16, 2009).

It is recommended that the goal of meaningful use is to enable significant and measurable improvements in population health through a transformed health care delivery system. The recommended definition of meaningful use is dependent upon healthcare setting. Some features

or capabilities may be required in hospital settings only after they are required in an ambulatory setting. The goals to satisfy meaningful use have been broken down into 2011 objectives, 2013 objectives and 2015 objectives. A full description of the meaningful use guidelines can be found in Appendix A.

The bulk of the funding available through the HITECH Act, US$17 billion, will be available to physicians and hospitals as incentives to promote the adoption of computer-based patient record (CPR) systems. These incentives will be issued to current users and new adopters of certified CPR systems, who use the systems in a meaningful way. Certification and standardization criteria are still underway and should be completed by the end of 2009.

Physicians are eligible to receive up to US$44,000 over the course of five years, commencing in 2011. The general payout schedule is in the following table:

Table 3.3: HITECH Act Payout Schedule

	Incentive Payment per Year (US$)						
Starting Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Total**
2011	18000	12000	8000	4000	2000	0	**44000**
2012		18000	12000	8000	4000	2000	**44000**
2013			15000	12000	8000	4000	**39000**
2014				12000	8000	4000	**24000**
2015					0	0	**0**

Created by author with data from Source: American Recovery and Reinvestment Act of 2009

The remaining $2 Billion will be dispersed as grants and loans to promote advancements in HIT and improve accessibility to HIT in underprivileged areas. The grants will be available to researchers, Community Health Centres, Rural Health Centres and Indian Health Centres.

The Office of the National Coordinator for HIT

The Office of the National Coordinator of HIT was established by Executive Order 13335 (Bush, 2004), issued by President George W. Bush on April 27, 2004. The National Coordinator was charged with ensuring coordination of federal health IT policies and programs and of relevant executive branch agency outreach and consultation with public and private entities. Thus, the National Coordinator provides the leadership necessary to support national progression to a health IT architecture.

In June of 2008 the Office of the National Coordinator of HIT issued a HIT Strategic Plan (Office of the National Coordinator of Health Information Technology, 2008) covering the period of 2008 through 2012. There were two goals of the plan, Patient-focused Health Care and Population Health. These are defined as follows:

> **Patient-focused Health Care:** Enable the transformation to higher quality, more cost-efficient, patient-focused health care through electronic health information access and use by care providers, and by patients and their designees.
>
> **Population Health:** Enable the appropriate, authorized, and timely access and use of electronic health information to benefit public health, biomedical research, quality improvement, and emergency preparedness.

Each of the goals had four areas of concern: privacy and security, interoperability, adoption, and collaborative governance.

As part of the ARRA a HIT Policy Committee and a HIT Standards Committee were created to provide recommendations to the National Coordinator for HIT related to standards, policy framework, implementation and certification criteria for the electronic transmission and

use of health information. The Standards Committee will focus on the policies developed by the Policy Committee.

The only organization currently recognized by HHS to certify HIT products and systems is the Certification Commission for Healthcare Information Technology (CCHIT).

Certification Commission for Healthcare Information Technology (CCHIT)

The CCHIT is a private non-profit organization focused on accelerating the adoption of robust, interoperable health information technology by creating a credible, efficient certification process.

CCHIT has been recognized by HHS as a certifying body since 2006. CCHIT is the only organization to have received federal approval to certify health IT products and systems. HHS recognition has been renewed annually (CCHIT, 2009). CCHIT uses the standards approved by the American National Standards Institute, Healthcare Information Technical Standards Panel (ANSI-HITSP).

American Medical Association (AMA)

The President-elect of the American Medical Association (AMA), James Rohack, M.D. said "The use of electronic medical records, and health information technology overall, holds great promise for improving patient care and increasing practice efficiency," at the 2009 annual Microsoft HealthVault Conference in Bellevue Washington on June 11, 2009. The AMA has a policy of working with other organizations on the development of standards for CPRs and HIT systems (AMA, 2007). The AMA is a member of a number of different organizations in the area

of standardization and HIT promotion. These organizations include the Computer-based Patient Record Institute (CPRI), American Medical Informatics Association (AMIA), and The American National Standards Institute (ANSI).

The HHS will issue an initial set of standards, implementation specifications and certification requirements by December 31, 2009. These standards, specifications and requirements will have an enormous impact on the certification and implementation of EMRs in the United States, and will most assuredly be copied by international standards setting organizations in the HIT field.

3.2.3 International

There are also a number of organizations that act to influence the development of HIT throughout the world. The most significant international organization as it relates to the HIT industry in North America is the Healthcare Information and Management Systems Society.

Healthcare Information and Management Systems Society (HIMSS)

HIMSS is an international healthcare industry membership organization that is focused on providing leadership in the area HIT and on the management of the betterment of healthcare.

HIMSS has offices around the world and represents more than 20,000 individual members. There are also more than 350 corporate organizations that hold HIMSS membership, these organizations include vendors, hospitals as well as other organizations involved in the HIT industry. HIMSS works to lead healthcare public policy and industry practices through advocacy, education and professional development. The mission of HIMSS is to lead change in

the healthcare information and management systems field through knowledge sharing, advocacy, collaboration, innovation, and community affiliations (HIMSS, 2009).

4: The Computer-based Patient Record

In the HIT industry and in the literature regarding HIT a number of different terms are used to refer to a computer-based patient record (CPR). The most common alternate terms used are electronic medical record (EMR) and electronic health record (EHR).

Computer-based patient record (CPR) will be use throughout this paper when describing the digital collection of health data for a single patient. This is equivalent to EMR or EHR use in some literature. There is some discussion in the HIT that EMR and EHR represent different types of records, the significant difference being the ownership of the record; either being owned and controlled by the health care provider or the patient (Garets & Davis, 2006). This differentiation does not have a significant impact upon the discussion of the benefits of the adoption of CPRs. This issue also lacks importance when looking at the barriers and implementation of CPRs in North America.

The authoritative definition of a CPR/ EMR is provided by HIMSS. That definition is as follows:

> "*The Electronic Health Record (EHR) is a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports. The EHR automates and streamlines the clinician's workflow. The EHR has the ability to generate a complete record of a clinical patient encounter - as well as supporting other care-related activities directly or indirectly via interface - including evidence-based decision support, quality management, and outcomes reporting*." (HIMSS, 2009)

4.1 History of the CPR

Computer-based medical records were first conceived of in the 1960's and first developed in hospital settings and focused on parts of the patient record that was easily structured such as diagnosis, laboratory results and medications. The inclusion of patient interaction notes proved to be more difficult. An early proponent of CPR's was Dr. Laurence L. Weed. Dr. Weed's innovation was to generate a medical record that would allow an independently verifiable diagnose. Dr. Weed founded PKC Corporation that produces coupler systems that match patient information with a medical database to provide individualized medical recommendations (PKC Corporation, 2009).

There are a number of systems developed in the 1970's that are still in use today. These systems were developed by specific hospitals or health care organizations to address the concerns of that environment. In general these systems were custom built for the specific setting there were deployed in and as a result represent a very large sunk cost for the organizations that have adopted them. The sunk cost represents the most likely reason these systems are still in use. Some of these systems are detailed in below.

Computer Stored Ambulatory Record (COSTAR): COSTAR was developed between 1968 and 1971 in by the Laboratory of Computer Science at Massachusetts General Hospital (Dick, The computer-based patient record: an essential technology for health care, Revised Edition, 1997). The first implementation of COSTAR was at the Harvard Community Health Pan (HCHP) which began using the system in 1969. By 1987 HCHP was using the system in its 9 care facilities. The system is modular, meaning a location only needs to install the components it

needs, and it also has an extensive dictionary that allows associations between different terms. These features allowed the system to be installed in a number of different clinical settings. In 1975 COSTAR was rewritten and made available in the public domain.

Regenstrief Medical Record System (RMIS): RMIS is one of the largest, longest operating (since 1973) and best studies medical record systems. It covers the population of the city of Indianapolis, IN. (the Regenstrief Institute, Inc. , 2006). It was one of the first medical record systems to generate reminders to physicians about its own content. RMRS serves as the day-to-day electronic medical records system at Wishard Hospital and its affiliated community clinics, Methodist Hospital, University Hospital and Riley Hospital for Children in Indianapolis.

Health Evaluation through Logistical Processing (HELP): developed at Latter-Day Saints Hospital at the University Of Utah (developed by 3M Corp.) Notable for its innovative decision support features

The Medical Record (TRM): Developed and used by Duke University Medical Center

Composite Health Care System (CHCS): the United States Department of Defense clinical care patient record system

De-Centralized Hospital Car System (DHCP): the United States Veteran's Administration system

These early systems not only suffer from significant technical and programming issues but also they are unable to communicate with each other as they use different vocabularies and programming languages without standard programming protocols (MITRE Corporation, 2006).

4.2 Current CPR

Less than one in five doctors' offices in the United States currently uses a computer-based file system. In other countries adoption is much better, specifically Denmark that has an electronic health system that almost everyone is connected to. Other European countries are building nationwide HIT networks. (The Economist, 2009)

Kaiser Permanente is a leading health organization in the United States that provides fully integrated care to its more than 8.6 million patients (Kasier Permanente, 2009). In 1999 Kaiser Permanente began the implement of an organization wide HIT system at a cost of over US$4 billion (The Economist, 2009). By 2009 Kaiser Permanente had implemented the system throughout its organization and had realized a 26% reduction in visits per patient through the use of e-mail and telephone consultations made possible by the system (Scott J. T., Rundall, Vogt, & Hsu, 2005).

Due to the cost of introducing a HIT system, and the risk of choosing a system that could become antiquated with the adoption of new standards in the HIT industry, only large health care organizations in North America have implemented HIT systems in a significant way.

4.3 CPR Components

The key capability of any CPR system (CPRS) is to consume and combine a large amount of data from various sources such as pharmacy, laboratory and radiology in addition to physician and nurse treatment notes. A CPRS must also deal with insurance and third-party billing information.

There are a number of different architectures that have been developed for CPRS. All CPRS must meet some basic criteria no matter how simple or complex they may be. The three areas of specific criteria are:

Functionality - ensuring that the systems can support the activities and perform the functions for which they are intended;

Security - ensuring that systems can protect and maintain the confidentiality of data entrusted to them; and

Interoperability - ensuring that systems implement the recognized standards and can exchange information and work with other systems.

There are three components of a CPRS. These components are the Computer-based Patient Record (CPR), which is the collection of all the health information pertaining to one individual; the Health Information Exchange (HIE), which is a system that allows for the storage and transmission of health information to the CPR from the third component; and the Data Production Modules (DPM). The DPM are application that capture patient data as entered by health care workers or medical equipment that is able to produce data automatically. It is only

through the interaction of these three components that a CPRS is able to collect, transmit, store and retrieve patient specific health information in an efficient way that can improve health care delivery.

4.3.1 Computer-based Patient Record

The CPR is the basis of the CPRS, it contains the patient information and is available to authorized providers to review and any new health information related to the patient is added to it. The key data elements required in the CPR are presented in Table 4.1.

Table 4.1: Components of a CPR

Function/ Application	Description
Practice order entry:	To support ordering lab tests, prescribing, diagnostic imaging or consult requests. Decision support and alerts are integrated into order entry capabilities.
Electronic patient record	Integrated storage and presentation of patient information
Document management	To allow clinicians to record in code or test the actions they have taken in diagnosing, managing and treating a patient. This can include physician and nurse progress notes, medication administration record, discharge record or continuity of care record (CCR)
Clinical decision support	Alerts based on current information from the electronic medical record, practice guidelines, or more sophisticated artificial intelligence system for diagnostic support provided at the time the clinician is assessing the patient and making treatment decisions
Administrative data	Access to administrative data such as admission, discharge and transfer records, surgery schedules, demographic data, room assignments, physician schedules, etc.
Integrated communication support	Tools such as secure email or messaging system that allows for effective communication between the care team and with the patient that supports continuity of care among multiple providers
Access to knowledge resources	Online information, including reference materials, journal articles, guidelines, etc. at the time decisions are made regarding patient care

Created by author, using information from Source: (Scott T. , Rundall, Vogt, & Hsu, 2007)

4.3.2 Health Information Exchange (HIE)

A HIE is a system that allows for the storage and transmission of digital information across organizations within a region or community. A HIE must have the capacity to deliver a wide variety of functions and services (The American Health Quality Foundation, 2006), including:

- Serve as a data exchange facilitator for a multitude of organizations including clinics, hospitals, imaging centers, pharmacies to support care delivery and chronic care management
- Provision to support consumers and patients use of personal health records
- Provision to support public health surveillance reports to public health agencies
- Provide information to support research activities
- Support quality improvement efforts by developing and delivering quality data reports to practitioners and payers with the consent of participating providers, payers and health care purchasers
- Coordinating incentives programs among purchasers, payers and providers.
- Supporting clinical process change and provider adoption of HIT

HIEs can be set up as a centralized data storage location with the information logically federated, but physically centralized. In this situation, when a specific patient record is accessed from a workstation the information is pushed to the workstation. A second, less efficient method of setting up a HIE is to have the different components of the patient record created by different applications stored at the source of creation, when the patient file is accessed the information is pulled from each of the locations to create the patient record accessible at a workstation.

An example of a HIE currently operating in North America is HealthBridge in Cincinnati; Ohio. Founded in 1997, HealthBridge is one of the nation's largest, most advanced and most financially successful community health information exchanges. HealthBridge provides connectivity for 29 hospitals, more than 4400 physician users. Each month HealthBridge delivers more than 2.4 million results to more than 4,400 physicians. This represents nearly 95% of the hospital sector activity in the Cincinnati region (HealthBridge, 2009).

There are also currently work being done in Alberta, Canada to institute a province wide HIE. The Alberta Netcare Health Information Exchange will become the central point to exchange data between the various systems that comprise the CPR system in Alberta (Alberta Netcare Health Information Exchange, 2009).

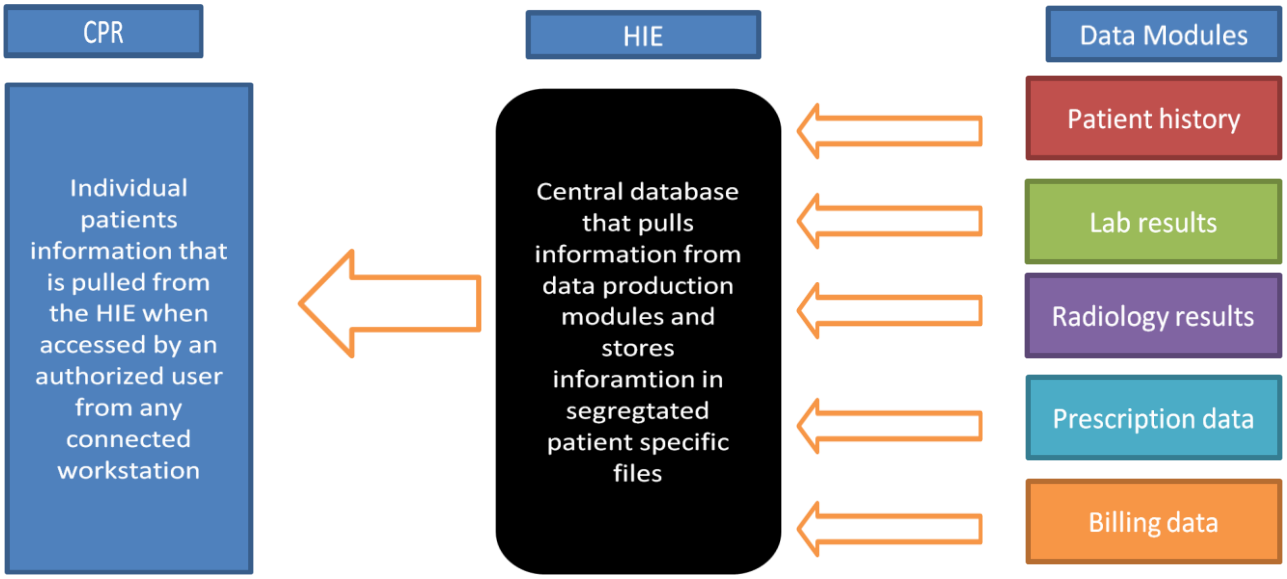
4.3.3 Data Production Modules (DPM)

DPM are the applications that health care workers can enter patient data into, as well as medical devices that produce data that can be electronically captured. A DPM is anything that produces data that can be stored in the CPR. Some of the data produced by DPM are:

- Physician and nurse notes
- Hospital discharge records, CCRs
- Diagnostic image creation
- Pharmacy application
- Referral creation application
- Patient record tracking software
- Best practice/ clinical practice guidelines application

A visual representation of the interaction of the CPR, HIE and DPM in a CPRS can be found in Figure 4.1.

Figure 4.1: Computer-based Patient Record System



4.4 Standards

To ensure interoperability and enable the transfer of information each part of the system must use the same set of data standards and use the same medical vocabulary and coding system for billing. There are a number of different organizations that are currently working on developing a unified international set of standards for CPRSs. Some of these organizations are the Healthcare Information and Management Systems Society (HIMSS), The American National Standards Institute (ANSI), Computer-based Patient Record Institute (CPRI), Certification Commission for Healthcare Information Technology (CCHIT), Canadian Institute for Health Information (CIHI) and Canada Health *Infoway* (*Infoway*). Without an international set of standards for CPRSs there will be a limit in the usefulness of these systems and the adoption of the systems will not deliver the maximum possible benefits of wide scale implementation of CPRSs.

4.5 Benefits

It is very difficult to measure all the benefits of the implementation of CPRS. There are quantitative benefits which are measurable and the basis for most business decisions; however, there are also a great number of qualitative benefits to the implementation of CPRS that present difficulties in analysis (Renner, May/June 1996). For this reason it is best to look at those benefits that can make the greatest difference in the operation and finances of the medical office.

In a comparative study in 2006 the importance of a number of potential benefits of the adoption of a CPR system were ranked on a scale to 10 based on the perceived importance (Thakkar & Davis, 2006). The rankings can be reviewed in the Table 4.2.

There are four distinct areas of benefit related to the use of a CPRS. These four areas of benefit are: Clinical, Workflow, Administrative and Revenue.

Table 4.2: Perceived Benefit of a CPRS

Benefits of Using an CPR System	Rank
Interoperability (exchanging patient information electronically) with other departments within the facility	7.33
Quality of care	6.84
Clinical workflow	6.25
Medical staff's work efficiency and time management	5.76
Patient safety	5.66
Interoperability outside the facility, but still within the entire healthcare system	5.35
Patient privacy and confidentiality	4.87
Business processes (strategic and operations)	4.72
Patient-doctor relationship	4.38
Cost of care	3.95

Created by author using data from Source: Thakkar & Davis, (2006)

4.5.1 Clinical Benefits

Clinical benefits are related to the expected improvements to patient care due to the adoption of a CPRS. The use of a CPR system increases the likelihood of a complete health record and eliminates the need for a limited medical record in each office (GP or specialist) the patient attends.

1. Complete, up-to-date patient records

Any change to the file, such as documentation of a clinical interaction, diagnosis or treatment is recorded in real time. Additionally, laboratory results, referrals or prescriptions are recorded in the appropriate file automatically.

The use of a CPRS can prevent the potential issues associated with the use of paper-based patient records. Some of most issues associated with the use of paper-based records were outlined in an article in the Journal of the American Medical Association (Smith, 2005). The issues that can be prevented by the use of a CPRS include:

- In 1 out of 7 visits, some important piece of data was not available at the time the patient was in the office.
- Nearly half the time (44%), physicians reported that the missing information was likely to adversely impact patients.
- The average time spent looking for missing data was 5 to 10 minutes-as much as half the time spent during a typical office visit.

The study also found that clinicians who reported having fully implemented CPRS were significantly less likely to report missing clinical information than those with a CPRS that did not completely replace the use of paper records.

2. Improve the organization and legibility of patient records

Through the use of standardized templates, printed text structure, and the ability for the physician notes to be typed instead of hand –written the organization and the legibility of CPR is well beyond that which can be expected of paper-based patient records. Errors associated with the incorrect interpretation of physician handwriting will be eliminated through the use of CPRs. CPR tools ensure each clinic note associated with a patient interaction is complete and the system use contributes to minimization of errors and helps standardize chart quality.

3. Improve decision making, improved disease management

A CPRS can include a point of care reminder system that provides physicians with practice guidelines related to diagnosis and can increase the number of maintenance appointments through the use of decision support reminders (Sandrick, 1998). A CPRS is able to schedule periodic preventive services such as mammograms, PAP smears, and colonoscopies and produces automatic reminders for the medical clinic as well as the patient.

4. Increase patient safety

The use of prescription management in the CPRS generates allergy alerts, active medication lists, notification of medication interactions and can produce customized patient medication handouts. These features greatly reduce the likelihood of incorrect or dangerous prescriptions, and increases patient safety. A study conducted in two U.S. teaching hospitals also revealed a 2% rate of preventable adverse drug events for all hospital admissions (Bates, 1997).

Patients report an improved perception of the physician practices that had a CPRS in use (Renner, May/June 1996).

4.5.2 Workflow Benefits

Workflow benefits are derived from the ability of CPRs to be accessed and updated by multiple individuals in multiple locations at the same time. This prevents repetition of work by more than one individual and prevents them from delaying their work waiting for another person to finish with the file.

1. Improved data intake

With the implementation of a CPRS the patients are no longer required to repeatedly record the same information regarding family history, personal history and billing, insurance information. There is no need to re-enter information even when the patient has not been in a particular office before. In a study conducted at University of Wisconsin Hospital and Clinics (Dassenko & Slowinski, July 1995) nurse intake time was reduced from 35 minutes to 20 minutes for initial office visits and from 35 minutes to 15 minutes for return visits at.

2. Ability of CPRs to support multiple users

A CPR can be accessed and changes can be made by multiple people in multiple locations in parallel. This prevents slowdowns in workflow related to one person waiting for other work to be complete before starting their task (Powsner, Wyatt, & Wright, 1998).

3. Reduction in the need for clerical/ support staff

The replacement of paper-based patient records with a CPRS results in a reduction in the workload of clerical staff. This workload reduction is due to the elimination of the need to produce physical charts as well as the elimination of the need to pull and re-file patient charts in a dedicated file storage area. Additionally, due to the data transfer capabilities of a CPRS the need to copy and send results or entire files by clerical staff is eliminated.

4. Reduction or elimination of transcription services

When physicians complete all required the documentation associated with a patient interaction at the point of care there is no need for dictation at the end of the day and no associated transcription required. Even with partial completion of patient interaction documentation there is a significant reduction in transcription required. The reduction in workload for in-house support staff, resulting from the decrease in the physical creation, pulling and filing of charts, can free the staff up to perform in-house transcription. This will decrease the turnaround time and increase the efficiency of transcription.

5. Improved staff communication through embedded messaging system/ secure email

CPRSs can have built-in email or instant messaging capabilities that result in improved staff communication by allowing staff to message each other from any workstation related to any CPR. (Scott, Rundall, Vogt, & Hsu, 2007). This increases the context in which staff can answer questions and increases the timeliness of response. CPRS also allow for remote access to patient

information over secure connections. This allows a physician or specialist to review a patient record from different locations, including home or another facility. This increases the convenience for physicians and increases the speed with which issues can be resolved.

6. Improved management of referrals, laboratory results, prescriptions and drug recalls

Referrals and prescriptions that are submitted through a CPRS are able to extract needed information from the CPR, eliminating the need for staff to manually prepare a referral or prescription. This has shown to reduce the turnaround time for referrals from one day to less than one hour, turnaround time for results posting was reduced from 36 hours to 24 hours and prescription preparation time was cut from 15 minutes to less than 3 minutes (Medicalogic, 2001). Drug recalls can be handled automatically, with a patient contact list generated from the CPRS in a fraction of the time required to go through paper-based records.

4.5.3 Administrative Benefits

Administrative benefits are the benefits derived by health care management through the increased ability to monitor physicians' performance and conduct trend analysis with CPRSs.

1. Improved physician performance monitoring

CPRSs allow health care managers to objectively monitor their providers practice trends and compliance with screening recommendations for mammograms and PSA testing. Compliance with best practices can be evaluated and physician's preferences can be tracked and comparison of treatment outcomes can be assessed. Data from the CPRS can also assist

management in better understanding how to position the organization in the market and inform future business planning such as equipment acquisition.

2. Research

The use of a CPRS makes data mining possible. This data can be used in research with patients' authorization as well as for public health purposes (Bemmel & Musen, 1997). Statistical analysis is significantly easier with electronic records and requires far less time and resources. Patient cases that might be relevant for medical education can be quickly identified and selected. As the information included in the CPR belongs to the patient there is a need for patient authorization to allow the use of the data for research purposes. In the case of public health data collection and data used for medical education there is not a need for specific authorization from the patient as all patient identifiers are stripped from the data before its use.

3. More efficient coding and insurance reimbursement process

CPRS include an automatic coding and billing module that can automatically submit billing for insurance reimbursement and eliminates the need for clerical staff to submit billing. The use of an automatic system will increase the accuracy of the coding, reduce the time it takes to bill and receive compensation and eliminate the delay in billing when information from an off-site source is required (Medicalogic, 2001).

4. Increased patient information security

The information in a CPR can be backed-up or stored at a secure remote sight, thus decreasing the risk that the information will be lost in the case of a fire, flood or other disaster. Unlike paper-based records digital records can be exactly duplicated as they are created and housed off-site to prevent the loss of all the information they contain in the case of an emergency. CPRs also automatically create a record whenever anyone accesses them. This allows a higher level of security and a method for tracking and limiting who has access to a patient chart. CPRs may only be accessed by individuals that the patient has authorized; this decreases the likelihood of unauthorized patient record access. The CPR access record minimizes the concern related to unauthorized access to a patient's data by staff or external individuals. Through the creation of an exact back-up copy of the CPR and the ability to audit the access to a patients CPR the use of CPRs represent a significant improvement over paper-based records.

4.5.4 Revenue Benefits

Revenue benefits refer to the benefits of the implementation of a CPRS that produce direct financial gain to the practice that implements it, or to the health care system in general.

1. Increase maintenance visits

A CPRS is able to alert physicians regarding patients' overdue maintenance issues and the need to book a maintenance visit for the patient. In a fee-for-service setting this meets two objectives. It both increases revenue opportunities through the increase in volume of service and

ensures better care for patients (Mildon & Cohen, May 2001). This maintenance care has been shown to decrease the overall cost of care for patients. The annual cost of care for patients in a practice using CPRs (US$943) was 37% lower than those with paper-based records (US$1593) (Renner, May/June 1996).

2. Improved coding

CPRS generate revenue through the correct coding for services. Practice revenues can be lost due to down coding from an evaluation to a management level. This loss has been estimated to be as high as 15% of total practice revenue (Mildon & Cohen, May 2001). The use of CPRs allows providers to capture this lost income by making it easier to document visits and coding at the appropriate level.

3. Improved cash flow

Cash flow can be improved through better documentation and greater visibility on outstanding receivables. The billing cycle can be significantly shortened through the use of automatic invoice generation and submission. This has shown to result in a decrease in the billing cycle time of up to 50% (Medicalogic, 2001). Bills are paid quicker when they are issued sooner and by automatically issuing invoices for service penalties for late billing can be avoided. The use of a CPRS should result in a decrease in outstanding accounts receivable for providers currently using paper-based systems.

5: Technical Barriers and Recommendations

5.1 Overview

The barriers to CPRS adoption related to technology are not a product of the inability of the HIT industry to solve the problem involved in the development of a system. Rather, they have to do with the inability of the industry to come to agreements on standards and principles that allow interoperability and interconnectivity between their products. A lack of technology is not a barrier to the adoption of CPRS, the lack of a standard technical underpinning is. The technology needed to create a standardized, robust, interoperable CPRS is well within the technical capabilities of the HIT industry, and is in use in other industries such as banking. The function of a CPRS is in many ways the same as the function of popular web site Youtube. CPRS, just like Youtube, collects user generated content, stores the information in a data exchange and then push the requested data to a specific computer when a user requests it.

In settings where there have been standards imposed on a large, self-contained CPRS there have been successful implementation of limited systems in individual hospital and health groups. The CPRSs created and used by the US Department of Defence (DoD) and the US Veterans Health Administration (VHA) have been used for more than decade. However, these two systems as well as those deployed in individual hospitals or health groups are not fully compatible with each other and as a result only return a small measure of the benefit expected of wide spread CPRS implementation. In addition to issues related to standardization there is a second related group of technical barriers related to security and privacy of health information that must be addressed.

5.2 Standardization

Standardization is of paramount importance for the development and adoption of CPRS. There are currently multiple organizations in Canada, the United States and internationally are working toward the development of standards for use in CPRs. There are two areas of standardization that must be addressed. These are Standards for Interoperability and Standards of Terminology. Although there are numerous organizations developing CPR standards a couple of factors minimizes the likelihood of a "format war", similar to HD-DVD and Bluray in CPRS. The first factor that should prevent multiple proprietary standards from battling for market share is the ability of CPRS to translate data created in systems using different standards through the use of shared archetypes or templates (Chen, Klien, Sundvall, Karlsson, & Ahlfeld, 2009). A second factor that will play a significant role in preventing the development of multiple CPRs standards is the size United States CPR market. The US market is the largest, most lucrative market in the world for CPRSs; as a result the standards that are adopted by the United States have an extremely high likelihood of become the default industry standards. For vendors it is advantageous to produce a product that conforms to the standards of the largest market, and as a result development costs can be minimized through the development of a CPRS that conforms to the standards of the largest market, the United States.

5.3 Standards for Interoperability

There is active work being done in Canada and the United States to establish a comprehensive set of content standards for CPRs.

In Canada the Canadian Institute for Health Information (CIHI) is working with *Infoway* to develop standards with each organization having specific areas of responsibility. *Infoway* is

leading the development of EHR Solution standards and acts as the overall program manager for EHR standards-related work. CIHI acts in the capacity of Preferred Partner to *Infoway* in the development of these standards. CIHI is also responsible for data definitions, content standards and classification systems. These represent the core of CIHI's business (Losier, 2003).

In the United States the Certification Commission for Healthcare Information Technology (CCHIT) has been designated by the US Department of Health and Human Services (HHS) as the certification body for all CPRS in the United States. The most influential standard making body is the ANSI-HITSP in the United States. This is because the United States represents the largest market opportunity for CPR vendors and as a result it is highly likely the standards adopted by the United States will by default be the international standards. The CCHIT uses the standards developed by ANSI-HITSP in its role as HHS designated certification body for CPRSs. The ANSI-HITSP is a public/private partnership with the goal of harmonizing and integrating standards that will meet clinical and business needs for sharing information among organizations and systems. ANSI-HITSP has approved 13 sets of interoperability specifications (ANSI-HITSP, 2009). The complete list of interoperability specifications can be found in Appendix B.

HIMSS has endorsed the use of CCHIT certification criteria and published a proposed set of definitions of "meaningful use of qualified EHR technologies" by hospitals and physician users (HMISS, 2009). HIMSS key criteria for "meaningful use of qualified electronic health records" are:

1. Utilization of an EHR certified by CCHIT.
2. Demonstrated ability to electronically exchange standardized patient summary data with clinical and administrative stakeholders.

3. Demonstrated practice of electronic prescribing.
4. Demonstrated reporting of quality and patient safety data.

Standards adoption represents a significant challenge for the HIT industry. Without interoperability standards the difference components of the CPRS will be unable to work together and the system implementation will be deprived of much of its potential benefit. The most widely used standards for CPRSs are the Health Level Seven (HL7) standards and GEHR/openEHR standards.

HL7 standard

Health Level Seven (HL7) is an international non-profit organization accredited by ANSI. HL7 produces a set of open standards for communication that allows health information systems developed independently to automatically "talk" with one another. HL7's domain is clinical and administrative data (Health Level Seven, 2009). The HL7 standards focus on the interface required of the entire health care organization, while other efforts focus on one particular department, such as pharmacy, medical devices or imaging.

HL7 specifies a number of flexible standards, guidelines and methodology by which various health care systems can communicate with each other. HL7 develops a number of different standards. These standards are listed in Table 5.1.

Table 5.1: HL7 Standards

Standard	Designation	Domain
Conceptual	HL7 RIM	Reference information model
Document	HL7 CDA	Clinical document architecture
Application	HL7 CCOW	Clinical context object workgroup
Messaging	HL7 v.3.0	Defines how information is packaged and communicated from one party to another

Compiled by the author from Source: (Health Level Seven, 2009)

HL7 standards are rapidly becoming the global standard in this area as evidenced by the growing number of official international HL7 affiliates. HL7 is being supported by *Infoway* in Canada.

GEHR/openEHR standard

The project began in 1992 as a European Union initiative dubbed the Good European Health Report (GEHR) that was completed in 1994. In 1999, an open source foundation was established to take forward harmonization in the field, from patient and clinical perspectives. The name openEHR was adopted. Currently, the project is maintained by the openEHR foundation.

OpenEHR is an open standard specification that describes the management and storage, retrieval and exchange of health data in CPRs (openEHR, 2009). In openEHR all health data for a patient is stored in a life-long, vendor independent, patient centred CPR. The focus of openEHR is not the exchange of data between systems; this is the domain of messaging standards such as those of HL7.

The openEHR's information model is the archetype. An archetype is a re-usable, formal model of a domain concept that is authored as a text file. Each text file defines one openEHR specification document (Beale, 2006).

5.3.1 Standards of Terminology

The medical terminology and vocabulary use in a CPRS are other areas in which standardization is needed to ensure system interoperability. Without a structured standard vocabulary an automated system will not be able to recognize two terms as being equivalent. Common vocabularies are essential for the exchange and use of information across different providers and different systems.

Implementing standardized clinical vocabularies and disease ontologies into a CPRS can alleviate terminology inconsistencies when data is captured at the point of care. There are two standard protocols that define such clinical vocabulary and disease ontologies. The first of is Logical Observation Identifiers, Names and Codes (LOINC) (LOINC, 2009) for ordering lab tests. The second is Systematized Nomenclature of Medicine—Clinical Terms (SNOMED-CT) for recording test results. SNOMED is developed by The International Health Terminology Standards Development Organization (IHTSDO, 2009). Both LONIC and SNOMED-CT provide well-defined meanings for specific terms that can be standardized across applications. These vocabularies lead to more detailed and relevant clinical analyses, but only when they are implemented in a uniform way.

The implementation of a common clinical vocabulary is especially difficult and must be addressed both with current health care workers, but also in collaboration with medical schools to ensure future health care workers share a common language.

5.4 CPRS Adoption Recommendations Regarding Standards

There are two categories of standards that must be addressed to enhance the positive network effects of wide spread CPRS adoption. One is the standardization related to interoperability and the other is standardization of terminology. To minimize the risk associated with the implementation of a CPRS I recommend the following: a) Wait for the CCHIT and HHS to announce their choice for certification and select system components from the certified vendors and b) Adopt SNOMED-CT as a standard medical vocabulary for all health care workers. The reasons for these recommendations are as follows.

a) Wait for the CCHIT and HHS to announce their choice for certification and select system components from the certified vendors

Standardization is vitally important to ensure interoperability of different CPRSs between different providers using systems from different vendors. The work currently being done by ANSI-HITSP to establish standards for CPRSs represent an important step in feasibility of large scale CPRS implementation.

I expect a significant development in the resolution of the standardization barrier to adoption will be the release of the certification criteria to be issued by the CCHIT to the HHS in the United States by the end of 2009. By waiting for the decision of CCHIT and then selecting a

certified CPRS a practice should be able to mitigate the risk of adopting a system that lacks interoperability with other systems used in North America. The decision by CCHIT is of vital importance as the United States represents a huge market for CPRS vendors and it is highly likely vendors will treat the standards adopted in the US as the worldwide standard.

Once standards are established it has been demonstrated that a large organization can see significant value through the adoption of a CPRS. An example of a successful implementation is the use of the VistA system of the United States Veterans Health Administration (VHA) for over 10 years (VistA Software Alliance, 2009).

The need for standardization is a very significant barrier to the adoption CPRS. By waiting for the ANSI-HITSP standards and adopting a system that is guided by them an organization can maximize the likelihood the CPRS is compatible with a maximal number of other CPRSs.

b) Adopt SNOMED-CT as a standard medical vocabulary for all health care workers.

As with technical standards it is important to select vocabulary standards that will maximize the number of systems that will be able to communicate with the chosen CPRS implemented. SNOMED-CT is considered to be the most comprehensive, multilingual clinical healthcare terminology in the world. The US Department of Health and Human Services has recommended SNOMED CT as part of a core set of patient medical record information (PMRI) terminology. It is important to ensure current health care workers use the specific medical vocabulary, as well as hire new employees that have been trained in the specific vocabulary.

5.5 Data Security

There is a perception that by digitizing patient medical information there is an increase in the vulnerability of that data. Many people are concerned that their medical information could be accessed or stolen from a CPRS. Although there is always a chance that any data stored on a connected server, however secure, could be vulnerable, the likelihood that a CPR is accessed by an unauthorized person is less than the chance a paper based record could be accessed.

There are a number of security features built into CPRs that actually increase their security as compared to paper-based records. These include:

1. Electronic audit trail: an automatically created record of who accesses the CPR, from where they access the record and what has been changed
2. Password protection: use of passwords or hospital access-cards to gain access to the CPR
3. Patient selects who has access: a patient must specifically authorize who has access to the CPR and may change who has access at any time
4. Enhanced server security: the use of protocols and tool similar to those used for electronic financial activities

Through the use of these tools the CPR has a significantly higher level of security than a paper-based record that can be picked up and read by anyone, with no record and no obstacles. This increased level of security present in CPRS is important as a breakdown in the security of a paper-based record can result in access to a single patient record at a time, where as a security

breach of a CPRS could result in multiple patients' data being compromised. The scope of a breakdown in data security is a trade-off that must be made to enable the benefits of a CPR, but the increase in security of a CPR as compared to a paper-based record significantly decreases the likelihood of the security breakdown.

5.6 CPRS Adoption Recommendations Regarding Data Security

Data security in the health care industry is of utmost importance. A prevention of a breakdown in the security of health care data must be guarded against with the adoption of CPRS. In order to minimize the risk associated with the security of health data I recommend the following: a) Choose a system that uses data security protocols that conform to ISO 27001 and ISO 13606 standards; b) Use a system access application at the workstation that uses the practitioner's access card or identification badge and password to gain access to the CPRS; c) Single portal access to the entire CPRS (only log in once, no matter how many types of data you are looking for); and d) Patient must authorize everyone who has access to their CPR, access management built into the system.

a) Choose a system that uses data security protocols that conform to ISO 27001 and ISO 13606 standards

As with standardization, data security is highly dependent on a diverse group of shareholders to have a consensus on the industry norm. As discussed earlier, much of the concern related to health data security is not a lack of actual security but rather the public perception of insecurity. The most important issue that must be resolved to eliminate the barrier

to adoption of CPRSs related to security is the public perception of the security of health data. By promoting the enhanced security and privacy features of a CPR over a paper-based record and by educating patients about the measure taken to secure their data the acceptance of digital health data can be increased. The public confidence in the security of data stored in CPRSs can be bolstered by conforming to standards governed by the International Organization for Standardization (ISO) related to information security management systems (ISO 27001) and health informatics (ISO 13606) (The Information Portal for ISO, 2009).

b) Use a system access application at the workstation that uses the practitioner's access card or identification badge and password to gain access to the CPRS

Many hospitals and health care groups use physical identification cards to access the hospital. These cards can also be used to identify the user at a computer workstation, through the use a card reader attached to the workstation. The use of this identification badge and a password can give staff on-time credential certification access to the CPRS. Through the use of the badge and personal password health care workers can access the system at any work station within the hospital quickly and securely. Upon the removal of the badge from the card reader the provider will be logged out to prevent others from using that provider's access. This also allows the system to give an individual health care worker access to only those CPRs to which they have been authorized by the patient and prevents unauthorized use of individual providers log-in.

c) Single portal access to the entire CPRS (only log in once, no matter how many types of data you are looking for

A CPRS can be made up of a number of different data bases with different types of medical information on each, such as radiological images or prescription tracking applications. Presently, there is often a need for a health care professional to enter their credentials each time

they request information from each database. This need to sign-in multiple times represents a waste of time for the health care worker and an annoyance. This can be avoided by the use of a single portal access to all the data, no matter what its origin.

d) Patient must authorize everyone who has access to their CPR, access management built into the system

There are currently specific security requirements for health information specified in Canada, set out by Health Canada (Health Canada, 2001) and in the United States Designated by HHS (HHS, 2007). The information stored in a CPR is in many regards more secure than the data stored in paper based health record systems as there is credential authorization that must be completed before viewing CPRs and there is a automatically produced a digital record of access and changes made to the record. There is an electronic trail of who has accessed the data and what changes were made. The replaced data is also retained in case the changes need to be reversed if they represent incorrect information.

6: Human Factor Barriers and Recommendations

6.1 Overview

Much of the interaction between the overall reform of healthcare and the use of CPRSs is in the area of workflow. The question has been: should the CPRS simply support the current workflow, or should the workflow be optimized through the adoption of the CPRS? It is clear that the greatest benefit would be realized through the adaptation of workflow to maximize the use of the CPRS. Not only does this represent the opportunity to maximize the return of CPR adoption, but it also is the more difficult choice from a personnel point of view. A change in how things are done will come with a certain level of reluctance and trepidation from the individuals who must change how they do their job. This reluctance must be the focus of the adoption strategy in relation to the health care worker stakeholder group.

Of course, health care professionals are not the only stakeholder group affected by the implementation of CPRSs. In order to successfully adopt a CPRS one must address the barriers that are presented by each of the stakeholders in the implementation and use of the system. These stakeholders include patients, health care workers, health care management, medical device and systems producers, government and non-profit organizations and the insurance industry.

The eHealth Initiative (eHI) is an independent, non-profit, multi-stakeholder organization that works to drive improvements in the quality, safety and efficiency of health care through information technology.

In December of 2008 the eHI presented the *eHealth Initiative Blueprint: Building Consensus for Common Action and eHealth Initiative Consensus Policy* (eHealth Initiative, Dec 2008) to key congressional leaders in the United States, as well as President-elect Obama. The eHI recognizes the need for the various stakeholders involved in the health care industry to share a level of trust that enables divergent interests to come together for a common cause of improving health care, despite market pressures to do otherwise (eHealth Initative, May 2007).

The *eHI Blueprint* is a consensus on a shared vision and a set of principles, strategies and actions for improving health care through information technology. Over 200 organizations were involved in the development of the Bluepront, representing a diverse group of stakeholders including clinicians, consumers, employers, health care purchasers, health care IT suppliers, insurance health plans, hospitals and other providers, laboratories, pharmaceutical and medical device manufacturers, pharmacists and pharmacies, public health agencies and state and community based organizations. A foundational element of the eHI is the recognition that HIT is not an end unto itself but rather a way to promote higher quality, safer, more value-driven and accessible health care.

The key elements of the blueprint are:

1. Engage consumers: HIT can empower patient s to engage in their own care in partnership with providers. The guiding principles to encourage patient engagement are:
2. Transforming care delivery: Through the use of HIT help providers deliver care that meets six aims- safe, effective, efficient, equitable, timely and patient-centered. The guiding principles for transforming care delivery are:
3. Improving population health: electronic clinical data can support and enhance public health interventions, chronic care management, quality improvement, provider

performance measurement, research and surveillance. The guiding principles for improving population health are:

4. Aligning financial and other incentives: health care providers should be rewarded appropriately for managing the health of patients in a holistic manner. The guiding principles are:
5. Managing privacy, security and confidentiality: technological development must be done in concert with policies and business rules that foster trust and transparency

The recommendations of the eHI represent views that aim to satisfy all the stakeholders involved in health care and are an important guide to building the consensus needed to successfully implement CPRSs.

Of the stakeholders involved the patients and the health care workers have the most exposure to changes without direct influence upon the decision making regarding CPRS adoption. It is for this reason that these are the two stakeholder groups that must be dealt with to overcome adoption barriers to the implementation of CPRSs. The first of these stakeholder groups we will address is the patients.

6.2 CPRS Adoption Recommendations Regarding Human Factors

Health care is centred on the treatment of patients by physicians and nurses. These stakeholders are fundamental to the success of CPRS adoption, specifically the support of these stakeholders.

6.2.1 Patients

Much of the reluctance from patients and the public related to CPRSs if focused on the security and privacy of health data. As discussed earlier much of the publics' concern related to security is due to a lack of familiarity and a general perception of on-line data vulnerability. The security of digital medical information is actually beyond that of paper-based records and has advantages related to access auditing over physical records.

To gain the support of patients in an effort to increase the likelihood of successful CPRS adoption I recommend the following: a) Clearly inform the public of the security features built into the CPRS that improve data security over what is possible in paper-based records; and b) Develop a patient-centric CPRS, empower the patient to oversee their own medical care and take ownership over the medical and health management. The reasons are as follows.

a) Clearly inform the public of the security features built into the CPRS that improve data security over what is possible in paper-based records

By educating the public about the benefits of CPRS adoption and the increase in security that is possible the barrier of patient distrust should be eliminated. Over 80% of the population of Canada believes the use of CPRs would be beneficial (Canada Health Infoway, 2008). In the United States the figure is 67% (Anderson, 2009). This illustrates that there is an understanding amongst the public that CPRS adoption is beneficial and a needed addition to the health care system.

b) Develop a patient-centric CPRS, empower the patient to oversee their own medical care and take ownership over their medical and health care management.

There is a need to adopt CPRSs that not only give value to the provider but that also integrate into patient focused products that also provide value. This customer demand has been

identified and is currently being addressed by personal health care initiatives by Google (Google, 2009) and Microsoft (Microsoft HealthVault, 2009). These types of services un-tether an individuals' health record from a provider and gives an individual ownership of their own record.

By creating a patient-centric system it is possible to create a knowledgeable customer that will demand a better CPRS solution. These patients will show the preference for CPRS equipped providers by choosing those providers. Thus the adoption of a CPRS becomes a competitive advantage for providers working in private health care settings.

However, there is a fine line that must be navigated between a patient centred system and one that encourages patient to diagnose and treat themselves. Self-diagnosing has become an issue with the ease of access to enormous amounts of information created by the internet. Self-diagnosis should not be encouraged, but with increased information available to the patient there should be encouragement to learn all they can about their disease and treatment.

In Canada and the United States the ownership of and access to medical records is somewhat ambiguous. It is mostly agreed that patient do not own the physical medical records, but they do have ownership of the information in those records (Jackson, 2005). The digitization of medical information removes the physical limitations of the medical record as it is simply a collection of data. Patients' rights to access to this data has not changed it is simply made easier. The privacy of all medical data, digital or otherwise is protected by privacy legislation in Canada and the United States. The ease of access to medical data increases the possibility that patients will become more involved in their health, both positively and negatively. Overall, the benefit derived from patient engagement far outweighs the cost.

An informed customer who demands the adoption of a CPRS is the best motivator to speed the adoption of CPRs for a provider. By focusing the change on the patient one can hope to maximize the value of system adoption and use the implementation as a business driver.

6.2.2 Health care workers

The wide spread adoption of CPR by practices throughout North America is dependent upon the acceptance of the medical personnel involved to accept the change and use the new systems. This has traditionally been an issue as medical staff resistance to significant operational changes related to CPR use. Most of the resistance by medical personnel currently will take the form of individuals avoiding the use of the new technology, in settings where physicians are not required to use these systems they tend to continue to use their old, preferred system

Several factors for physician resistance to the use of CPRS have been cited in Brailer and Terasawa (2003). The most significant factor are:

- Computer anxiety
- Increased time to enter orders and patient histories
- Decreased patient- physician interaction
- Inability of applications to integrate into workflow
- Lack of knowledge, need for education

The first factor, computer anxiety is one of the more easily overcome sources of resistance as the use of computers has become ubiquitous in North America, and there is a generation of health care workers that have grown up tethered to a computer for much of their

life. The other factors are a combination of perceived issues that can be debunked through the hands-on use of the system (increased order entry time and decreased patient interaction); and issues that can be sufficiently addressed with a well organized, thoughtful implementation of CPRS. An additional step that can diffuse much of the resistance from health care workers is to share the experience of physicians who use CPRSs currently with good results.

In order to increase the adoption of CPRS I recommend the following steps to deal with the barriers presented by health care workers: a) Identify and support CPRS champions; b) Institute a phased roll-out of a CPRS and provide time for education and in-house educators for each step of the implementation; and c) Adopt a modular CPRS that has a user interface that presents a familiar work environment for casual computer users.

a) Identify and support CPRS champions

In order for many physicians and medical workers to adopt the use of CPRSs there is a need for physician champions who are first adopters and are able to share their successes with CPRSs with their colleagues. It is only through doctor-doctor interactions that may medical workers will be convinced of the use of CPRs. To stimulate the acceptance of CPRSs among health care workers it is important to answer the question "how will CPRs make my job easier?" This can be done through seminars, work exchanges, on-site demonstrations and conferences dedicated to promoting the adoption of CPRS.

b) Institute a phased roll-out of a CPRS and provide time for education and in-house educators for each step of the implementation

As with the implementation of new work system there is a learning curve, and the need for staff education. This is barrier in two ways as education is a cost that must be addressed with

the implementation of a CPRS, but it also is a barrier as health care workers have limited time to learn a new system. It is important to not overload health care personnel with too much information, and for that reason it is recommended that there is a phased roll-out of a CPRS with specific training time set aside for each phase and in-house educators available to help with on-going learning. A phased implementation works best with a modular CPRS.

c) Adopt a modular CPRS that has a user interface that presents a familiar work environment for casual computer users.

In order to overcome the barriers presented by the need to learn a new system a CPRS should be as intuitive in its operation as possible, and present a environment that feel familiar to computer users. This can be addressed through the development of a graphical user interface, and the use of standardized templates for as many functions as possible.

A modular system that can use different applications from different vendors to create a complete CPRS should be used. This type of system will allow for the use of the best application for a particular job, independent of the vendor. This is an important outcome of standardization that allows seamless interoperability.

7: Financial Barriers and Recommendations

7.1 Cost Barriers

The most often cited barrier to the implementation of a CPRS is related to the cost of implementation. There are those who argue that the cost associated with the implementation of a CPRS is simply the cost of doing business, but most providers want to see a quantitative as well as qualitative return on the investment.

Financial resource availability is a major concern for medical practices independent of size (Brailer & Terasawa, 2003). As part of the federal budgets in Canada and the United States, as well as the HITECH Act as part of the ARRA in the US, there are currently more financial resources available to support the adoption of CPRSs than ever before. The costs associated with the implementation of a CPRS can be categorized as follows: Cost of software, hardware, infrastructure development and maintenance, implementation, education, planning and administration.

CPRS are regarded as expensive items and usually includes a large upfront flat-fee as well as licensing fees per user. A study by the Indiana Academy of Family Physicians (Loomis & Ries, 2002) found that 87% of family physicians surveyed would implement a CPRS if the upfront cost was US$5000 or less and the monthly licensing fee was less than US$100 per user per month. Unfortunately, the average upfront cost of a CPRS ranges from US$20,000 to US$50,000 and monthly charges are US$200 to US$600 per user.

7.1.1 Canada

In the 2009 Federal Budget Canada Health *Infoway* was allocated $500 million to "speed up the implementation of electronic medical record systems for physicians and integrated points of service for hospitals, pharmacies, community care facilities and patients." *Infoway* is responding to this new opportunity in a number of ways including investments to increase the number of physicians utilizing EMRs, as well as supporting vendors to upgrade their solutions, utilizing pan-Canadian standards, so they are interoperable with provincial EHR infrastructures (Canada Health Infoway, 2009). The $500 million investment brings the Government of Canada's total investment in EHR systems to $2.1 billion to date.

The federal government's support has enabled *Infoway* and its jurisdictional partners to make considerable progress to date – resulting in 276 projects completed or underway across the country; there are active projects in every province and territory.

7.1.2 United States

As part of the HITECH Act of 2009 the US federal government has allocated US$31.2 billion for HIT, with a net value of US$19.2 billion. Of that allocation US$17 billion is specifically designated to support EHR development.

However, due to the for-profit model of the US health care the cost of CPRS is still a concern. An individual physician is eligible for up to US$44000 over a five year period with the implementation and meaningful use of a CPRS. If a CPRS cost US$150,000 to set up and run over the same period there is still little motivation for physicians in the US to adopt a CPRS.

7.2 CPRS Adoption Recommendations Regarding Cost

It is important to find ways to minimize the cost CPRS implementation, while not sacrificing function. Fortunately there is evidence that there is not a direct correlation between the cost of care and the quality of care in the United States (Fisher, 2009).

A good example of how to minimize cost and maximize function is the system currently used at the New York-Presbyterian Hospital Group. By choosing to use a vendor based system and through the use and re-use of patient data the New York-Presbyterian Group has been able scale the size and capability of its CPRS with minimal upgrading expenditures (Boyer, 2009).

It is of utmost importance that the barriers related to cost be addressed in order to stimulate the adoption of CPRS in North America. I recommend the following steps to address the barriers related to cost: a) Adopt a modular CPRS that uses various applications fron various vendors; and b) Create Regional Health Information Exchanges that act as a central store house of patient information. The rational for these recommendations follows.

a) Adopt a modular CPRS that uses various applications from various vendors

By choosing to implement a modular system that uses the best-in class applications for the various functions required of the CPRS a provider can hope to avoid the cost of development of a custom system and enables separate application to be updated or replaced by improved applications without the need to replace any of the rest of the system.

b) Create Regional Health Information Exchanges that act as a central store house of patient information.

By cooperating with other providers a single provider can share the cost of data storage and CRPS development between a number of providers, thus reducing the burden on any one specific provider. An example of this type of health exchange is HealthBridge in the Cincinnati, Ohio area.

HeathBridge was founded in 1997, and is one of the nation's largest, most advanced and most financially successful community health information exchanges. HealthBridge connects 29 hospitals working as a third party organization, working with all participating healthcare stakeholders to facilitate creation of an integrated and interoperable community healthcare system (HealthBridge, 2009). The key difficulty in forming these types of information exchanges is the reluctance of competing providers to share patient information with their competition, as a result these types of information exchanges are harder to establish in a private health care setting such as the United States (Hepp, 2009).

In an ideal world these regional health information exchanges could be interconnected in a national or even international exchange that would allow free movement of personal health records. This should be the ultimate goal to work towards.

8: Business Case for CPRS Adoption

In the for-profit model of health care in the United States it is very important to produce a business case with a compelling return on investment (ROI) when trying to implement a CPRS. In the US health care system different health care providers are competitors and the only way to create large scale interoperable CPRSs is through the cooperation of competing hospitals and doctors' offices. In order to convince these competitors that they will have a larger gain than loss is through the presentation of a compelling business case. It is imperative to illustrate that the creation of a wide-spread CPRS creates value for everyone and does not simply transfer value from one participant to another. The implementation of a CPRS increases the size of the financial pie, and provides a competitive advantage to those involved.

In Canada it is important to build a business case for health care spending, but due to the nationalized health care model there is currently less focus on the ROI of CPR implementation and more focus on the benefit to patient care than in the US. There has been work done over the last few years on the development and fine tuning of the business case for CPRSs by both private industry and government. The introduction of financial incentives for the development and adoption of CPR by the governments of Canada and the United States is helpful in improving the ROI for CPR adoption. As evidenced by the entrance into the CPR industry of firms such as Microsoft, Google, General Electric and IBM there is a business case to be made for the implementation and use of CPRSs.

The cost of implementing a CPRS has consistently been identified as the top barrier to adoption. For this reason practices that have implemented CPRSs are more likely to be larger

institutions, major teaching hospitals, part of a large hospital system or located in urban areas (Jha, et al., 2009).

Some of the barriers related to cost have been lessened or eliminated with the introduction of the HITECH Act in the United States and the increase funding for *Infoway* in Canada over the last year. With the average cost of implementation of a CPRS about US$35,000 and the HITECH Act funding of US$44,000 per physicians there is less resistance due to the cost of CPRS. To further promote the adoption of CPRSs vendors such as General Electric have offered zero percent financing for their health record solution system to bridge the funding gap between the implementation of a system and the reception of HITECH Act funds (General Electric, 2009).

8.1 Value of CPRS Adoption

The value of a CPRS in a small group practice was assessed in fourteen different practices that implemented CPRSs (Miller, West, Brown, Sim, & Ganchoff, 2005). The average practice paid for its CPRS costs in 2.5 years. Table 8.1 shows the costs, both implementation and ongoing, and the benefits of the CPRSs adopted.

The average practice had a net benefit of US$24,325 in the second year of CPRS operation. This offsets the average net cost of US$19,501 in the first year and results in an average benefit at the end of the second year of US$4,824

Table 8.1: Costs and Benefits for Small Group Practices

	Average per provider ($)	Median ($)	Minimum ($)	Maximum ($)
Software training, installation	22,038.00	22,834.00	8,475.00	32,607.00
Hardware	12,749.00	12,492.00	5,261.00	23,600.00
Lost revenue from reduced productivity	7,473.00	7,473.00	0.00	20,000.00
Other	1,145.00	0.00	0.00	9,652.00
Installation costs	43,826.00	45,747.00	14,462.00	63,600.00
Increased coding levels	16,929.00	21,250.00	3,040.00	41,711.00
Efficiency gains	15,808.00	14,611.00	1,000.00	50,700.00
Efficiency savings	13,144.00	12,444.00	1,000.00	42,500.00
Personnel savings	6,759.00	8,333.00	5,333.00	30,000.00
Transaction savings	5,334.00	10,800.00	8,500.00	12,000.00
Paper supply savings	1,051.00	1,000.00	500.00	5,333.00
Increased revenue gains from increased visits	2,664.00	8,200.00	6,600.00	22,500.00
Total benefits	32,737.00	38,450.00	6,600.00	56,161.00
Net benefits/ cost	(11,089.00)	(7,297.00)	(7,862.00)	(7,439.00)
Ongoing cost per year	8,412.00	7,231.00	5,957.00	11,867.00
1st year net benefit/ cost	(19,501.00)	(14,528.00)	(13,819.00)	(19,306.00)
2nd year net benefit/ cost	24,325.00	31,219.00	643.00	44,294.00

created by author with data from Source: (Miller, West, Brown, Sim, & Ganchoff, 2005)

8.2 Case Studies

It is important to consider both large health care practices as well as small health care practices when looking at the impact of the adoption of CPRS. It is for this reason I have chosen to review the results of CPRS from two dissimilar health care practices.

8.2.1 Small Practice: Family Care of Concord, Concord, New Hampshire (Janas & Morrison, 2009)

The practice consists of two physicians, two nurse practitioners and support staff of three registered nurses, two licensed practical nurses and three medical assistants. The practice manages 7200 active patients and averages 1200 patient visits per month. The practice opened in April of 1996 with a CPRS installed by MedicaLogic, a private, Portland, Oregon based HIT firm.

Table 8.2: Benefits and outcomes of CPRS adoption at Family Care of Concord

Benefits	Outcome
Elimination of Transcription: Family Care of Concord was able to eliminate all transcription costs by using structured flow sheets, note templates and point-of-care documents.	Net savings to the practice of US$43,780 per year.
Chart Pulls: All paper charts have been eliminated.	Net savings of US$24,500 annually
Prescription Generation: Prescriptions are generated as a by-product of the documentation process. Through the use of the CPRS the time to generate a prescription is reduced from 15 minutes to less than 3 minutes.	The estimate of the saving for the year is US$71,400
Coding: The CPRs eliminates the need to manually code for billing.	The automatic coding resulted in savings of US$5,950 per year.
Laboratory Interface: The tests received from the laboratory are automatically filed in the CPRs.	The elimination of the need to file laboratory results is estimated to be a savings of US$5,525
Referrals: Referrals are generated as a result of the patient interaction	The time saved by the automatic referral generation is US$7,140 annually
Qualitative Reporting: The CPRS automatically reports quality indicators to qualify for managed care payor's incentive bonus program.	Through the use of the CPRS the practice was able to qualify for the maximum quality bonuses.
Drug Recalls: 4 drug recalls affecting 45 patients have occurred.	All the affected patients received a letter within one day of the recall
Hospital Inpatients: The practice generates approximately 760 hospital admissions per year.	By allowing access to the complete CPR the providers are able to have the maximum amount of information to support clinical decision-making.
Patient Satisfaction: The average patient satisfaction rating within the local health region was 88.2%	The patient satisfaction at Family Care of Concord was 88.9%.

Compiled by the author with data from Source: (Janas & Morrison, 2009)

The practice had measured net annual cost reduction of approximately US$121,300 (US$30,300 per provider). In addition to the financial improvement realized through the CPRS adoption there were several quality improvements recognized. The Practice was able to respond faster to prescription refill requests, alert patients in the case of drug recalls, notify patients of laboratory results and speed referral initiation.

8.2.2 Large Practice: Sarasota Memorial Hospital, Sarasota, Florida (Eclipsys Corporation, 2004)

Sarasota Memorial Hospital is a progressive community hospital that provides a broad range of care. The facility employs 725 physicians and had operating revenue of US$450.5 million in 2007 (Sarasota Memeorial Hospital, 2008). Sarasota Memorial Hospital uses a CPRS developed by Eclipsys Corporation, an industry leader in providing process improving technology solutions to major health care providers. The benefits and outcomes of the adoption of the CPRS at Sarasota Memorial Hospital are covered in Table 8.3.

Table 8.3: Benefit and outcome of CPRS implementation at Sarasota Memorial Hospital

Benefits	Outcome
Financial:	In the year 2002 reduced turnover rate and associated costs of training. • Savings of at least US$289,520 versus the national average and US$727,936 versus Florida average in 2002. • By replacing paper flowsheets, assessments and other documents saved US$122,251. • Eliminated approximately US$135,000 annually by redesigning workflow. • Through the use of e-Learning solutions saved approximately US$4,500 in training cost annually.
Quality of Care:	• Improved consistency of care through the automatic creation of a fall risk assessment tool.
Improved nurse documentation:	• 100% Increase in chart compliance with all review items • Completion of Braden Scale for Skin Assessment increased from 86% to high 90% range • Improved plan of care/ problem list dynamic updating with patient condition change from 85% to 100% • Improved documentation of patient education from 75% to 100% • Improved documentation of pain index from 80% to 88% or higher
Productivity:	• Eliminated double documentation of orders • Saved approximately 3000 phone calls per month to notify providers when orders were written • Reduced the number of full time case managers while increasing the number of reviews

Compiled by author with data from Source: (Eclipsys Corporation, 2004)

8.3 Return on Investment and Payback Period

Based on the simplistic cost and benefit analysis of the implementation of a CPRS by a single GP, undertaken by the author using publically available data from the CMA, it is expected a physician could expect a first year ROI of 0.33 and a net revenue increase of $113,398.53 over a five year period. The calculations used to arrive at these financial results can be found in Appendix C. The payback period for the CPRS implementation and monthly maintenance cost is calculated to be 13 months, 12 days (13.40 months). This analysis is only based on the increased patient volume that could be achieved through the use of CPRS and the cost savings

associated with the elimination of transcription services. The actual financial impact of the implementation of a CPRS is well beyond patient volume increase and elimination of transcription costs.

Additional benefits could be realized through the reclamation of space currently being used to house paper-based records, the elimination of file creation, pulling and filing activities.

8.4 Health Care Reform

There is a currently a great deal of debate on the future health care reform in the United States and in Canada. The adoption of CPRSs is a component of this move to reinvent the delivery of health care services in North America. Specific health care reforms can have a significant impact upon the adoption of CPRSs. These reforms are in the areas of payment structure; workflow and patient engagement. Changes in these areas are needed to motivate timely adoption of CPRSs in North America

Payment structure

There are two significant reforms that must be made to health care payment structures in North America. The first is a movement from a pay for service structure that is currently in place to a pay for performance structure (P4P) for physicians. The second reform is the need for the Medicare system in the US and the Medical Services Plan in Canada to enable the coding and billing of non-office based patient encounters such as e-mails or remote video consultations. CPRS adoption would be significantly encouraged by these changes in the payment structure as they allow improved monitoring of performance and enable physicians to increase the number of

different ways they can interact with patients, including those that are lower cost than the traditional in-office appointment.

The current method of payment to physicians is payment for each interaction or procedure that is done. This gives the health care provider a motivation to order additional tests, schedule more frequent visits and prescribe other care that does not necessarily produce better health incomes for the patient.

In the current system there is little financial motivation for keeping patients healthy, and out of the doctor's office. This is in conflict with the adoption of CPRS that act to improve physician decision making and provides reminders consistent with the most up-to-date standards of care. Through better decision making and a standardized treatment regime there is expected to be significant health care cost savings. A P4P payment system has been instituted in the United Kingdom since 2004 and has seen quality improvements that have been beyond the forecast. However, the cost savings have not, to this point, lived up to the predications of the implementation (Galvin, 2006). Using the lessons learned from the UK it can be expected the implementation of a P4P system in North America should encounter fewer difficulties and realize greater returns.

The AMA has identified the need for there to be a specific coding option for e-mail correspondence or video correspondence through the Medicare payment structure (AMA, 2009). Without a billing code for these types of patient interactions physicians will not adopt a CPRS that makes non-traditional contact with patients using technology an important component in health care delivery. However, if these types of interactions can be billed physicians will be willing to replace traditional office visits with other types of communications. As a result,

systems that enable these other types of communications will be more widely adopted by providers.

Workflow

Don't just add technology to the current system, but change workflows to maximize the benefit of CPRS adoption. Hammer and Champy argued that companies should redefine the way they do things instead of using computers to replicate inefficient processes in their book *Reengineering the Corporation: A Manifesto for Business Revolution* (1993).

Health care must undertake a process of business process reengineering to improve health outcomes, efficiencies, and reduce overall costs. It is only with changes to workflow that the benefits of CPRS can be realized. The simple adoption of CPRS on top of inefficient processes will not return the benefit predicted of implementation.

Patient engagement

Traditionally, when a patient is involved in an interaction with the health care system they have more pressing concerns than the efficiency of their provider and the services offered to them as a customer. A patient is generally in a position where they are completely dependent upon their physician for information and do not feel they have any power to make the system work for them.

Customer demand can act as a powerful motivator for changes in any industry. In health care, an informed customer that demands ownership of their health and treatment is the greatest advocate for the adoption of CPRS. If patients choose a practice based on the presence of a

CPRS and the associated benefits then there will be an competitive advantage to implementing a CPRS, and at some point the adoption of a system and its associated costs will be seen, not as a tool that must have a significant financial return, but rather as a tool that is indispensible to a health care practice.

The most influential stimulus for the adoption of CPRSs is a customer who demands it be in place. For a consumer to demand the use of a CPRS that consumer must be aware of the qualitative benefits it will provide. An informed customer and informed patient is the key to large scale adoption of CPRSs in North America.

9: Conclusion

The main barriers to the wide spread adoption of CPRSs in North America are financial concerns regarding cost and return on investment; human concerns regarding the need for training and gaining acceptance by all stakeholders; as well as technical concerns regarding standardization and data security.

Through the work industry groups and cooperation amongst CPRS vendors the standardization issues are quickly being addressed, and it is highly likely there will be a clear industry standard in place by the first quarter of 2010 with the US HHS issuing their standards by December 31, 2009. Regarding the issue of data security it is clear that there are security and privacy controls in place and the issue of security is more an issue of perception than reality.

With new providers, who have grown up using computer systems and have a high level of computer literacy, entering the health care industry it is expected the barrier of computer acceptance in a health care setting will subside. This leaves the barrier of the need for training on CPRS. Training is a barrier in any setting when an innovation is introduced. As long as the initial project budget includes a contingency for ongoing training and time is allocated for this purpose training should not be a barrier to adoption.

This leaves us with the financial barrier to adoption. There has been a great deal of research regarding the implementation of CPRSs and the associated financial benefits. With more implementations, each day there is more and more proof that the adoption of CPRSs does have a compelling return on investment and the benefits to a health care practice go well beyond the financial return.

Health care reform plays an important role in the adoption of CPRS. Specifically, the reforms in the three categories identified in this paper; payment structure, workflow reengineering and patient engagement/ customer demand. With the proper reforms in place the adoption of CPRS should be greatly accelerated and the cost associated with the implementation of a system will be seen more as a cost of doing business, a cost of competing in the health care industry than an investment that must be recovered and profited from.

The most important factor in the adoption of CPRS is perception of the general public, of patients. If consumers demand the adoption of CPRSs the industry will respond. This is the key; an informed consumer will demand the benefits of CPRS adoption. It is through this patient engagement that wide spread implementation of CPRSs will be moved forward. The combination of the current financial incentives in the United States and Canada with the health care reforms underway in each country are creating an environment where health care practices who have adopted CPRSs will become the norm, the question is how to minimize the risk of this implementation. Although the recommendations in this paper may seem somewhat basic it is important to realize the cumulative effect of these recommendations will be to minimize the risk and the cost of implementing CPRSs while also maximizing the benefits of wide spread CPRS adoption.

Appendix A: Meaningful use matrix

Compiled by author based of information form Source: (Meaningful Use Workgroup- Health IT Policy Committee, June 16, 2009)

Health Outcomes Policy Priorities	**Care Goals**	**2011 Objectives** ***Goal is to electronically capture in coded format and to report health information and to use that information to track key clinical conditions***	**2011 Measures**	**2013 Objectives** ***Goal is to guide and support care processes and care coordination***	**2013 Measures**	**2015 Objectives** ***Goal is to achieve and improve performance and support care processes and on key health system outcomes***	**2015 Measures**
Improve quality, safety, efficiency, and reduce health disparities	Provide access to comprehensive patient health data for patient's health care team Use evidence-based order sets and CPOE Apply clinical decision support at the point of care Generate lists of patients who need care and use them to reach out to patients (e.g., reminders, care instructions, etc) Report to patient registries for quality improvement, public reporting, etc	Use CPOE for all order types including medications [OP, IP] Implement drug-drug, drug-allergy, drug-formulary checks [OP, IP] Maintain an up-to-date problem list [OP, IP] Generate and transmit permissible prescriptions electronically (eRx) [OP] Maintain active medication list [OP, IP] Maintain active medication allergy list [OP, IP] Record primary language, insurance type, gender, race, ethnicity [OP, IP]	Report quality measures, including: - % diabetics with A1c under control [OP] - % hypertensive patients with BP under control [OP] - % of patients with LDL under control [OP] - % of smokers offered smoking cessation counseling [OP, IP] % of patients with recorded BMI [OP] % eligible surgical patients who received VTE prophylaxis [IP] % of orders entered directly by physicians through CPOE	Use evidence-based order sets [OP, IP] Record clinical documentation in EHR [IP] Generate and transmit permissible prescriptions electronically [IP] Manage chronic conditions using patient lists and decision support [OP, IP] Provide clinical decision support at the point of care (e.g., reminders, alerts) [OP, IP] Report to external disease (e.g., cancer) or device registries [OP (esp. specialists) [IP] Conduct medication administration using bar	Additional quality reports using HIT-enabled NQF-endorsed quality measures [OP, IP] % of all orders entered by physicians through CPOE [OP, IP] Potentially preventable Emergency Department Visits and Hospitalizations [IP] Inappropriate use of imaging (e.g. MRI for acute low back pain) [OP, IP] Other efficiency measure (TBD) [OP, IP]	Achieve minimal levels of performance on quality, safety, and efficiency measures Implement clinical decision support for national high priority conditions [OP, IP] Medical device interoperability [OP, IP] Multimedia support (e.g. x-rays) [OP, IP]	Clinical outcome measures (TBD) [OP, IP] Efficiency measures (TBD) [OP, IP] Safety measures (TBD) [OP, IP]

Health Outcomes Policy Priorities	Care Goals	2011 Objectives *Goal is to electronically capture in coded format and to report health information and to use that information to track key clinical conditions*	2011 Measures	2013 Objectives *Goal is to guide and support care processes and care coordination*	2013 Measures	2015 Objectives *Goal is to achieve and improve performance and support care processes and on key health system outcomes*	2015 Measures
Improve quality, safety, efficiency, and reduce health disparities		signs including height, weight, blood pressure [OP, IP] Incorporate lab-test results into EHR [OP, IP] Generate lists of patients by specific condition to use for quality improvement, reduction of disparities, and outreach [OP] Send reminders to patients per patient preference for preventive /follow up care [OP, IP] Document a progress note for each encounter	Use of high-risk medications in the elderly [OP, IP] % of patients over 50 with annual colorectal cancer screenings [OP] % of females over 50 receiving annual mammogram [OP] % patients at high-risk for cardiac events on aspirin prophylaxis [OP] % of patients with current pneumovax [OP] % eligible patients who received flu vaccine [OP] % lab results incorporated into EHR in coded format [OP,IP] Stratify reports by gender, insurance type, primary language, race, ethnicity [OP, IP]				

Health Outcomes Policy Priorities	**Care Goals**	**2011 Objectives** ***Goal is to electronically capture in coded format and to report health information and to use that information to track key clinical conditions***	**2011 Measures**	**2013 Objectives** ***Goal is to guide and support care processes and care coordination***	**2013 Measures**	**2015 Objectives** ***Goal is to achieve and improve performance and support care processes and on key health system outcomes***	**2015 Measures**
Engage patients and families	Provide patients and families with access to data, knowledge, and tools to make informed decisions and to manage their health	Provide patients with electronic copy of- or electronic access to- clinical information (including lab results, problem list, medication lists, allergies) per patient preference (e.g., through PHR) [OP, IP] Provide access to patient-specific educational resources [OP, IP] Provide clinical summaries for patients for each encounter [OP, IP]	% of all patients with access to personal health information electronically [OP, IP] % of all patients with access to patient-specific educational resources [OP, IP] % of encounters for which clinical summaries were provided [OP, IP]	Offer secure patient-provider messaging capability [OP] Provide access to patient-specific educational resources in common primary languages [OP, IP] Record patient preferences (e.g., preferred communication media, advance directive, health care proxies, treatment options) [OP, IP] Documentation of family medical history [OP, IP] Upload data from home monitoring devices [OP]	Additional patient access and experience reports using NQF-endorsed HIT-enabled quality measures [OP, IP] % of patients with access to secure patient messaging [OP] % of educational content in common primary languages [OP, IP] % of all patients with preferences recorded [OP] % of transitions were summary care record is shared [OP, IP] Implemented ability to incorporate data uploaded from home monitoring devices [OP]	Access for all patients to PHR populated in real time with data from EHR [OP, IP] Patients have access to self-management tools [OP] Electronic reporting on experience of care [OP, IP]	NPP quality measures related to patient and family engagement [OP, IP] % of patients with full access to PHR populated in real time with EHR data [OP, IP]

Health Outcomes Policy Priorities	**Care Goals**	**2011 Objectives** ***Goal is to electronically capture in coded format and to report health information and to use that information to track key clinical conditions***	**2011 Measures**	**2013 Objectives** ***Goal is to guide and support care processes and care coordination***	**2013 Measures**	**2015 Objectives** ***Goal is to achieve and improve performance and support care processes and on key health system outcomes***	**2015 Measures**
Improve care coordination	Exchange meaningful clinical information among professional health care team	Exchange key clinical information among providers of care (e.g., problems, medications, allergies, test results) [OP, IP] Perform medication reconciliation at relevant encounters [OP, IP]	Report 30-day readmission rate [IP] % of encounters where med reconciliation was performed [OP, IP] Implemented ability to exchange health information with external clinical entity (specifically labs, care summary and medication lists) [OP, IP] % of transitions in care for which summary care record is shared (e.g., electronic, paper, eFax) [OP, IP]	Retrieve and act on electronic prescription fill data [OP, IP] Produce and share an electronic summary care record for every transition in care (place of service, consults, discharge) [OP, IP] Perform medication reconciliation at each transition of care from one health care setting to another [OP, IP]	Additional public reports using NQF-endorsed HIT-enabled quality measures [OP, IP] % of transitions where med reconciliation was performed [OP, IP] % of encounters where fill data accessed [OP] % of encounters where clinical information is shared with external clinical entities [OP, IP]	Access comprehensive patient data from all available sources	Aggregated clinical summaries from multiple sources available to authorized users [OP, IP] NQF-endorsed Care Coordination Measures (TBD)

Health Outcomes Policy Priorities	Care Goals	2011 Objectives	2011 Measures	2013 Objectives	2013 Measures	2015 Objectives	2015 Measures
Improve population and public health	Communicate with public health agencies	Submit electronic data to immunization registries where required and accepted [OP, IP] Provide electronic submissions of reportable lab results to public health agencies [IP] Provide electronic syndrome surveillance data to public health agencies according to applicable law and practice [IP]	Report up-to-date status for childhood immunizations [OP] % reportable lab results submitted electronically [IP]	Receive immunization histories and recommendations from immunization registries [OP, IP] Receive health alerts from public health agencies [OP, IP] Provide sufficiently anonymized electronic syndrome surveillance data to public health agencies with capacity to link to personal identifiers [OP,IP]	% of patients for whom an assessment of immunization need and status has been completed during the visit [OP] % of patients for whom a public health alert should have triggered and audit evidence that a trigger appeared during the encounter	Use of epidemiologic data [OP, IP] Automated real-time surveillance (adverse events, near misses, disease outbreaks, bioterrorism) [OP, IP] Clinical dashboards [IP, OP] Dynamic and Ad hoc quality reports [OP, IP]	HIT-enabled population measures TBD [OP] HIT-enabled surveillance measure [OP, IP]

Improve population and public health	Communicate with public health agencies	Submit electronic data to immunization registries where required and accepted [OP, IP] Provide electronic submissions of reportable lab results to public health agencies [IP] Provide electronic syndrome surveillance data to public health agencies according to applicable law and practice [IP]	Report up-to-date status for childhood immunizations [OP] % reportable lab results submitted electronically [IP]	Receive immunization histories and recommendations from immunization registries [OP, IP] Receive health alerts from public health agencies [OP, IP] Provide sufficiently anonymized electronic syndrome surveillance data to public health agencies with capacity to link to personal identifiers [OP,IP]	% of patients for whom an assessment of immunization need and status has been completed during the visit [OP] % of patients for whom a public health alert should have triggered and audit evidence that a trigger appeared during the encounter	Use of epidemiologic data [OP, IP] Automated real-time surveillance (adverse events, near misses, disease outbreaks, bioterrorism) [OP, IP] Clinical dashboards [IP, OP] Dynamic and Ad hoc quality reports [OP, IP]	HIT-enabled population measures TBD [OP] HIT-enabled surveillance measure [OP, IP]

Appendix B: ANSI-HITSP Interoperability Specifications

Source: (ANSI-HITSP, 2009)

1. EHR laboratory results reporting: (IS01) defines specific standards to support the interoperability between electronic health records and laboratory systems and secure access to laboratory results and interpretations in a patient-centric manner.
2. Bioserveillance: (IS02) defines specific standards that promote the exchange of biosurveillance information among healthcare providers and public health authorities
3. Consumer empowerment: (IS03) defines the data exchange between patients and health providers
4. Emergency responder electronic health records (ER-EHR): (IS04) define the ability to track and provide on-site emergency data for emergency responders
5. Consumer empowerment and access to clinical information via media: (IS05) define ability to exchange data between patient and provider via physical media or by secure email exchange
6. Quality: (IS06) define standards for inpatient and ambulatory care provides real time feedback regarding quality indicators for specific patients
7. Medication management: (IS07) define access to medication and allergy information
8. Personalized healthcare: (IS08) define standards for the recording of family history and genetic/ genomic laboratory orders and results

9. Consultation and transfer of care: (IS09) define standards for the information exchange as it applies to: 1. request for a specialist consultation 2. Transfer care of a patient to another facility
10. Immunization and response management: (IS10) define standards to:
    a. Provide information about individuals who need vaccinations
    b. Report, track, and manage vaccination programs and population quarantine programs
    c. Describe treatment or status of population
    d. Provide vaccine resource and supply chain information
11. Public health case reporting: (IS11) bi-directional info0rmation exchange of public case reporting process
12. Patient-provider secure messaging: (IS12) defines the ability to communicate through the use of commonly available consumer computer technology
13. Remote monitoring: (IS77) transfer of remote monitoring information from a device attached to a patients on-site

Appendix C: Return on Investment Calculations

Business case for CPR Adoption

	w/o CPRS	With CPRS	Notes:	
Chart pull (per pull)	20	1		Erstad, 2004
Chart cost (per chart)	3	0		Erstad, 2004
Transcription (hrs per week)	25	0.00		Erstad, 2004
Referral time	1	0.125		Erstad, 2004
Prescription time	1	0.2		Erstad, 2004

GP Increased Patient Volume

GP work hour per week	49.77	Notes:	CMA.ca
Direct patient care (hrs/wk)	33.36		CMA.ca
Indirect patient care (hrs/wk)	6.38		CMA.ca
Percent of work with patients	**79.85%**		

GP patients (per week)	117	CMA.ca
Avg. time per patient (hrs)	0.33965812	
GP time reduction with CPR	13.00%	Erstad, 2004
Projected avg. time per patient with CPR(hrs)	0.29550256	
Projected GP patients (per week)	134.482759	
Additional GP patients (per week)	**17**	

Average GP annual income	$133,187.00	Payscale.com
Income per patient	$21.89	
Additional GP income (annual)	$19,901.51	Addition of 17 patients per week, 52 weeks per year
Projected Income increase (pct.)	**14.94%**	

Transcription costs

Lines of transcription per patient	35	Medicalogic- White Paper: Establishing a Business Case
Cost per line of transcription	$0.11	digitscribe.ca
Cost per patient	$3.85	
GP patients (per week)	117	CMA.ca
GP patients (per year)	6084	
Transcription cost (per year)	$23,423.40	
Transcription cost with CPRS	0	
Savings with CPRS (per year)	**$23,423.40**	

ROI

Cost of CPR implementation	$32,606.00	MGMA survey
Predicted Net Gain	$43,324.91	
ROI	**0.33**	

Pay Back Period

Average CPR implementation (per Physician)	$32,606.00	MGMA survey

Average CPR maintenance per month	$1,177.00
Average CPR cost- first year	$46,730.00
Average CPR cost- after first year	$14,124.00
Predicted Increase in revenue (per year)	$19,901.51
Predicted decrease in expenses (per year)	$23,423.40
Predicted Net (per year)	$43,324.91
Predicted Net (per month)	$3,610.41
CPR return- year one	($3,405.09)
Pay back period (months)	**13.4**

MGMA survey

5 year return

Predicted net 5 years	$216,624.53
Average cost 5 years	$103,226.00
5 year return	**$113,398.53**

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