

**CANADA HEALTH INFOWAY'S
10-YEAR INVESTMENT STRATEGY COSTING**

Pan-Canadian Electronic Health Record

Implementation Strategy

March 2005

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Implementation Strategy

1.0 10-Year Implementation Strategy

Introduction

In July of 2004, Canada Health Inforoute (Inforoute) engaged Booz Allen Hamilton to develop a 10-year strategy to implement an integrated Pan-Canadian Electronic Health Record (EHR). The implementation strategy was to be based on rolling out EHR functionality. The ultimate goal would be to have an integrated, interoperable EHR that spanned the entire care continuum in hospitals, physician offices, public health offices, mental health facilities, long-term care facilities, and home care. This implementation strategy served as a basis for cost and benefits estimates discussed elsewhere in this paper. The following section discusses this implementation strategy.

Given the range of current EHR components and functionality, many permutations could be incorporated into a rollout plan. At a high level, Inforoute has embraced a conceptual framework of EHR functionality expressed in several generations.¹ The first generation system consolidates patient data for viewing, the second generation allows for the documentation of care and basic decision support, and the third generation provides the capability of physician ordering and improved decision support. Inforoute asked Booz Allen to develop a conceptual framework that could be used to plan for a third generation EHR by the end of 10 years.

Both the pace of implementation and the functionality implemented have a direct impact on when the financial benefits of the EHR are realized. The longer the time frame to complete implementation the more remote the benefits become. In addition, the less functionality available to the clinician, the fewer benefits realized. It is thus imperative to chart an aggressive course in implementation to realize benefits; however, resource constraints must be considered when deciding what can be realistically accomplished in the decade.

Our implementation strategy was devised by reviewing published literature on implementations and by speaking to those who have undertaken implementations. Nonetheless, we found that this is largely uncharted territory, and there are few published implementation strategies against which to benchmark our strategy. The Institute of Medicine has published a guideline of what it believes can be reasonably implemented in a 7-year time frame.² In a frequently cited study done by the Center of Information Technology Leadership (CITL) in Boston, MA, looking at return on investment (ROI) for EHRs, the group modeled an implementation occurring in year one, with benefits accruing by year two. In the United Kingdom, a 10-year time frame has been developed for the implementation of a full EHR. Likewise, the United States is striving towards an EHR for all Americans in 10 years. Australia has set a similar goal.

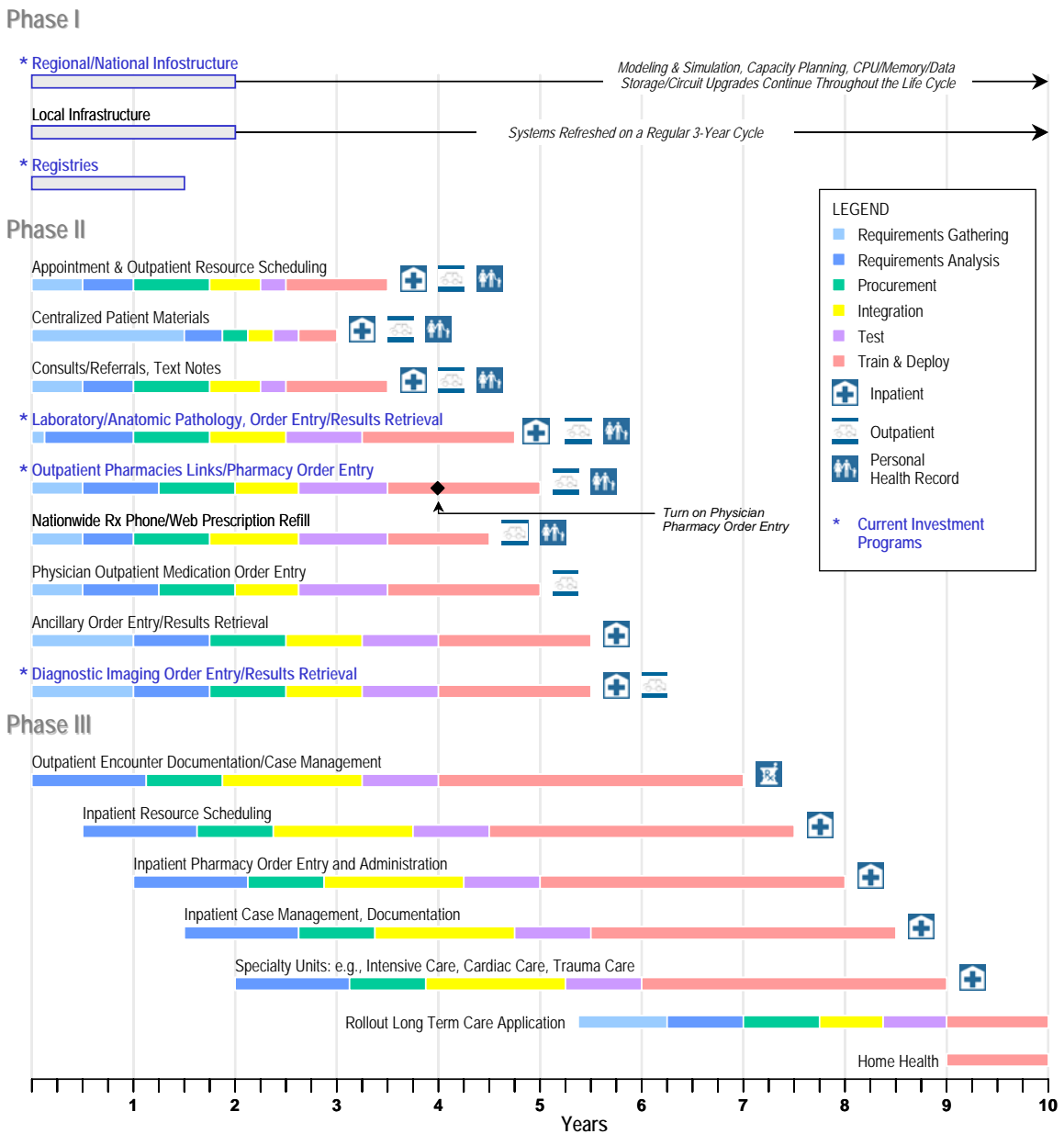
¹ Hieb B. CPR Generation Effectiveness in Reducing Medical Errors. Gartner Research Note. June 6, 2002.

² Institute of Medicine. Key Capabilities of an Electronic Health Record System. Letter Report. 2003. The National Academies Press. Washington, DC.

In developing a rollout strategy, we were cognizant of potential resource constrictions in Canada, not only related to funding available for a full Canadian implementation, but also centered on intellectual capital constrictions and the availability of skilled workers to carry out these implementations. Our strategy has thus struck a balance between the need for rapid implementation versus resource constraints. This strategy concentrates on first bringing up applications in hospital and physician settings: 5 years to outpatient physician office implementation, 8 years to hospital implementation, and 10 years to long-term care implementation. Hardware for home health is distributed at year 8. This schedule is thought to be realistic and achievable, while still allowing time for cost benefits to be accrued. Given the need for requirements gathering, analysis, and a procurement process, a quicker implementation was not thought to be realistic.

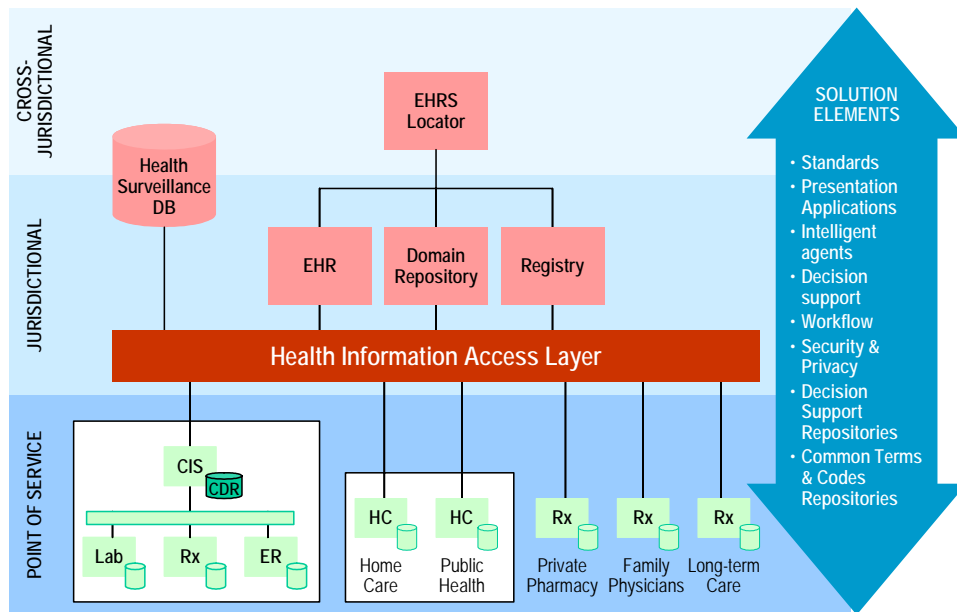
We have proposed a three-phase approach for functionality rollout for a Pan-Canadian EHR. These three phases, and the sequencing within them, are depicted in Figure 1 and described in the subsequent sections. At the end of the third phase, the third generation of EHR functionality is in place, although it is reached in a different fashion than if one moved in order from generation to generation. In the first phase, the emphasis is on setting the foundation that supports the EHR. This phase lays the infostructure that connects the entire care continuum to the Pan-Canadian EHR, laying the groundwork for the ultimate connection of pharmacies, labs, public health offices and clinics, acute care, physician offices, mental health facilities, long-term care and hospitals to the EHR. The second phase allows for the capture of clinical data, e-prescribing, outpatient order entry, centralized patient education materials, and the integration of pharmacies. The third phase introduces full outpatient and inpatient care documentation and case management. The sequencing within the phases has been structured to gradually introduce clinicians to EHR functionality in an effort to smooth their transition and enhance acceptance of these new tools.

Figure 1. The Three-Phase Approach



In a truly integrated EHR, data would be stored in Clinical Data Repositories (CDR), linked at a provincial level. Applications within care settings would store data in this CDR and pull data for use within the applications. The numbers of CDRs would be based on types and numbers of facilities and the numbers of individuals anticipated to be associated with a given CDR. Data may thus be stored locally, provincially, or nationally. The Health Information Access Layer (HIAL) would allow for the data to be accessed across these areas so that health care providers would be able to view the patient data critical to provide safe, high-quality care (see Figure 2).

Figure 2. EHRs Conceptual System Architecture Model



Source: Canada Health Inforoute

In large urban hospitals, on-site health care information technology systems are the norm and are a logical choice. However, for hospitals located in more rural areas, this model becomes prohibitively expensive. Likewise, mental health facilities, long-term care facilities, many physician offices, and public health facilities have too few users in these facilities to justify the cost of having complete free-standing Health Information Technology (HIT) systems housed within. This expense has been one of the barriers preventing slowing the adoption of EHRs into those care settings outside of large urban hospitals. In the model we envision, large facilities with many users would host applications, while smaller facilities would either share applications with local hospitals or would share applications remotely via an Application Service Provider (ASP) model. With time, specialized software unique to these care settings would be introduced to accommodate the workflows of these providers.

Mandates within public health, such as surveillance and immunization programs, make public health settings somewhat unique. Many public health facilities in Canada today are already using applications to aid in their work, and others are undergoing implementations. These applications create separate public health databases. In our model, we have accounted for the necessary connection and interfaces so that these databases can be linked to the EHR.

Of note, Inforoute has many current investment programs underway that have included key building blocks for an EHR. They began by concentrating on the collection and storage of patient data: laboratory systems, diagnostic imaging systems, and drug information systems. These systems account for 80% of patient data. In addition, Inforoute has investment programs in registries and telehealth. Telehealth programs are well underway in many provinces and are being developed in parallel with the Canadian EHR. As the EHR becomes more robust, so will

telehealth—EHRs are a key enabler of a successful telehealth initiative. Missing from the investment programs today are those items that round out critical pieces of an EHR to improve safety and quality of care for patients: orders, robust decision support, alerts, rules, and reminders. Also absent is scheduling, a key feature that helps to improve management of wait lists. Once in place, these components collectively would give Canadians an EHR that would allow for third generation capability—the greatest enabler of improvement in quality of care and patient safety.

Infoway directed Booz Allen to devise a rollout schematic of components that various facilities could adopt within their own time frame and with their own needed components. There is, however, an alternative methodology to approaching a Pan-Canadian interoperable, integrated EHR. Rather than have a rollout of components and functionality, Canada could plan for a mass procurement and a “big bang” method of implementation. This alternative would allow Canada to realize large cost savings. This alternative approach is discussed in detail in Section 2.

Detailed Implementation Strategy

1.1 Phase I: Years 0–3

Local, regional, jurisdictional, provincial, and national infra/infrastructure would be built in this phase, placing the emphasis on building the foundation to support the EHR. The infostructure, that infrastructure that lies outside the walls of a health care facility or provider office, is an essential foundation for a Pan-Canadian EHR. During this phase, the regional and national infostructure, as envisioned by Infoway, would be implemented. Also during this time period, requirements gathering and analysis for early EHR functionality would commence.

Phase 1

- A. Regional/National Infostructure
- B. Local Infrastructure
- C. Registries
- D. Requirements Gathering

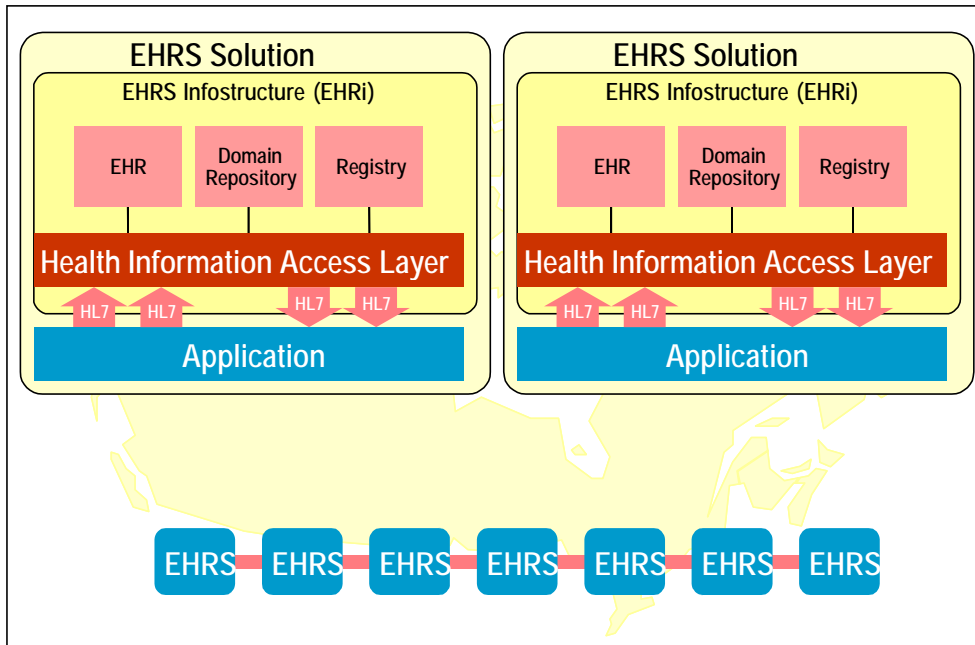
1.1.1 Regional/National Infostructure

T0 to T + 30 Months

The EHR infostructure (EHRi) brings together registries services, EHR data, and EHR services, such as security and messaging standards (data services, business services, messaging services, interoperability, integration services, security services, subscription, management, general, context, and protocol services). Part of the EHRi resides in the HIAL layer, which allows for the exchange of information between the actual applications residing within a health care facility and the repositories where the information is stored. Combined, the EHRi and the applications make up the EHR Solution (EHRS). The “solution” thus is the totality of the local applications combined with the infostructure (see Figure 3).

To reach the goal of having a basic EHR in place for all Canadians by the end of 10 years, the focus must be implementing all components of the infostructure and the architecture around it. Infoway already has begun to invest in infostructure, and this work will continue.

Figure 3. EHR Solution



Source: Canada Health Infoway: EHRs Blueprint

As part of Infoway’s current infostructure investments, significant work is already underway to study, model, pilot, test, and develop the replicable-shared components of the needed architecture and data repositories. Phase 1 includes the completion of jurisdictional, provincial, and national data centers and bringing CDRs online.

In addition, the wide area network (WAN) capacity and circuits would be established at this time. Primary communications pathways for non-local area network (LAN) Infoway traffic would be high bandwidth, high availability, redundant, leased Asynchronous Transfer Mode (ATM) permanent virtual circuits (PVC) with a quality of service (QoS) of “Variable Bit Rate non-real time” (VBRnrt). For the smallest sites (< 40 users), a single point-to-point circuit, up to full T-1, may be used.

As clinical capability of the EHR is expanded, the CDR data structures would be expanded and capacity of databases increased. It is critical that system engineering, modeling and simulation, capacity planning, and database optimization continue throughout the life cycle to ensure robust performance as functionality is added. Constant monitoring of the system through automated tools and instrumentation should be performed to guard against degradation in performance or failure of components.

WAN Requirements

- Target sustained throughput of 300+ kilobits/sec (kb/s), to support a sustained bandwidth demand of 20 kb/s per active user.
- The throughput should not drop below 200 kb/s.
- Maximum latency should be < 100 milliseconds (ms) one-way, with less than 1% packet loss.
- The system should be designed to provide an uptime of 99.6%.
- Data security / encryption would be hardware-based virtual private network (VPN) tunnel.
- Network caching /compression (PTP and IP) should be considered.

As noted previously, prohibitive costs make it unlikely that smaller hospitals, physician offices, long-term care facilities, public health offices, and mental health offices would house their own IT systems. In this model, we assumed that these entities would connect to local hospitals or a regional Application Service Provider (ASP). We have estimated costs accordingly.

1.1.2 Local Infrastructure

Most hospitals have an infrastructure in place and would have achieved many or all of the milestones in this phase, and thus may proceed directly to the next phase. Many public health facilities are already populating databases with public health data, and they too may begin in the later phases. Likewise, many mental health facilities have been using their own specialized applications. However, some small hospitals and the majority of physician offices and long-term care facilities would need to start installing basic infrastructure to support the EHR.

The initial foundation would establish a minimum baseline of computing capability. During the first several years of the EHR program, while data centers, databases, and WANs are being created, clinicians would be gradually introduced to EHR capabilities. Previous surveys of technology availability to the local provider would be updated, and infrastructure upgrades would be provided. The goal would not be to replace existing infrastructure. Rather, the goal would be to fill capability gaps to bring providers within health care facilities up to a defined minimum baseline level of computing power, LAN, printer access, and links to the Internet with a reasonable connection speed.

For providers who are computer novices, e-mail, word processing, and accessing the medical literature via the Internet would allow them to gradually become comfortable navigating within a graphical user interface. The use of e-mail would increase communication efficiency and productivity, and access to the medical literature would facilitate improvements in quality of care. This incremented introduction of computer skills is the initial stage of change management.

1.1.3 Step 1: Initial Minimum Baseline

T0 to T+24 Months

Personal Computer

The functional target is to ensure that baseline PC characteristics allow a modern secure operating system and typical business software to function with reasonable operating performance. For purposes of discussion, this reasonable performance is defined as a PC capable of running Microsoft Windows XP Professional and Microsoft Office Professional. Minimum PC characteristics (detailed at right) would not provide the most “snappy” performance but should be sufficient as an initial infostructure baseline.

Minimum Personal Computer Baseline Requirements

- PC with Pentium II 450 MHz or higher processor (1.3 GHz Pentium 4 preferred)
- 256 MB of RAM or higher (512 MB suggested)
- 10 GB hard disk or better (20+ GB recommended)
- S-VGA or higher resolution video and 15" monitor (17" flat panel recommended)
- Ethernet 10 Mbps
- CD-ROM or DVD drive
- Standard keyboard and two-button mouse

If an intended EHR user already has access to this configuration of PC or better, that user does not require an upgrade. If an upgrade of components would bring the configuration up to the minimum standard, that upgrade should be applied. If an upgrade is not possible, or if the potential user needs to be provided with a new PC, the features outlined below in the “Updates Beyond Baseline” section would be applied.

Printers

Generally, an average of one printer should be available for every five PCs. Minimum printer baseline requirements are shown at right.

Minimum Printer Baseline Requirements

- 600 dots per inch (dpi) or better
- Grayscale
- Duplexer
- RAM upgrade
- High capacity paper tray (250-500 sheets)
- Ethernet 10/100 Mbps
- Wireless connectivity

Local Area Network and Web Access

LAN and Web access minimally needs category 5 cables, and Ethernet at 10 megabits/sec (100 Mbps recommended). If significant new LAN drops are required, wireless networks should be installed rather than fixed-drop networks.

1.1.4 Step 2: Updates Beyond Baseline

Years 3–10

Wireless Personal Computers

The PCs do not need significant computing power until imaging starts to roll out (see right). Thus, the limited PC power in the first 3 years is of little consequence. However, the first of the 3-year refreshes of PCs would provide significant infrastructure upgrades to support mobile wireless computing in all ambulatory patient care areas.

Tablet Based Wireless PCs

Improves on costs by:

- Eliminating LAN drops
- Eliminating monitors
- Eliminating multiple CPUs
- Reducing power consumption
- Reducing desktop space
- Increasing efficiencies

Providers would be issued a tablet PC as “their” computer. The use of wireless tablet PCs is consistent with the current trend in health care IT toward wireless LANs. If a facility uses fixed workstations in its EHR system, more than one complete PC system would be required per provider (> 1:1 ratio). For each provider, there would be a complete PC system at several different locations: a PC in their office, in each of their exam rooms, each treatment room, and so forth. Each PC would include CPU, monitor, LAN drops, electrical power, and desktop space. Using one wireless tablet PC per provider eliminates the costs for physical LAN drops, monitors, multiple CPUs, some amount of power consumption, and desktop space, providing significant efficiencies.

In our experience, physicians who use handheld wireless tablet PCs seem to gravitate towards using structured text rather than free text, because of the requirement of tapping an on-screen keyboard to type out free text. This structured documentation reaps benefits in searching, coding, and research capabilities.

As noted previously, PCs should be on a 3-year replacement cycle. This is common practice and allows for gradual enhancement of computing capability over time while keeping the cost per device relatively constant. In other words, the same dollars that buy a 1.1 GHz CPU this year would likely buy a 4.0 GHz CPU in 3 years.

There would be instances in which a fixed workstation makes sense. In those cases, we recommend the equivalent of the Motion M 1400 specs and flat screen monitors, which take up less space and have lower power requirements than CRTs.

Tablet-Based Wireless PCs

For wireless PCs, we recommend a minimum of:

- 1.1 GHz Centrino CPU
- 512 MB of RAM
- 20 GB hard drive
- Extended life battery
- 10/100 Mbps Ethernet
- Docking station
- Biometrics capability
- Built-in 802.11g high-speed wireless networking
- Bluetooth

Printers

At 5 years, the printers should be refreshed to wireless color laser printers where appropriate—minimum 600 dpi, upgraded RAM, wireless networking, duplexer. As with the other devices, there is a maintenance trail for the printers.

1.1.5 Registries

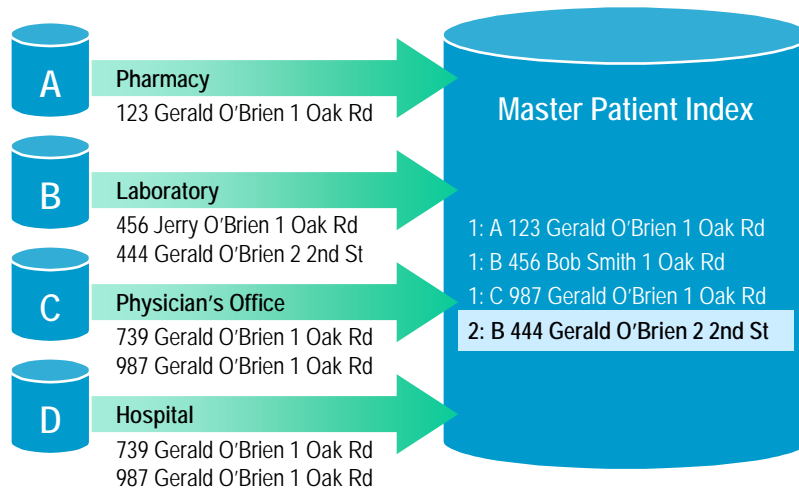
T0 to T+18 Months

Concurrently with the effort to upgrade infrastructure and construct the infostructure, work would be completed on the registries that identify patient/person, provider, location, consent, and disease.

The patient/person registry contains an index of patients in a Master Patient Index (MPI) system so that each patient’s clinical information is located in one place and is easily retrievable with the proper authorization. This registry becomes the “white pages” of patients. Although some have suggested the use of national patient identifiers, this concept remains controversial. However, individuals can be uniquely identified without assigning each citizen a number. A series of characteristics such as name, date of birth, gender, and place of birth may be sufficient to uniquely identify a given individual in the system.

Registry systems now have embedded logic to match a defined number of variables in order to match patients. These systems incorporate algorithms that can determine whether Matthew Smith = Matt Smith = Matthew Smyth. Variables are given different weights—for instance, matching by last name has a higher weight than matching on first name; matching on date of birth has a higher weight than first name. Common nicknames are matched as well so that Kate = Katie = Katherine. This capability makes searching for a particular individual faster and more accurate than in the paper world today. This registry also allows for the capture of patient demographic data as well as basic patient information, such as allergies and blood type (see Figure 4)

Figure 4. Enterprise Master Patient Index



Source: Canada Health Inforoute: EHRS Blueprint

Provider registries contain lists of all care providers, licensed and unlicensed. These registries can contain additional information about a provider, including education, credentialing and licensing status, and can be fed by licensing organizations to keep the information up to date. For unlicensed individuals, the information could be fed by professional organizations or by voluntary submission of the provider. This registry would create a “yellow pages” directory of providers in a given area. Patients would be able to go online and quickly find appropriate providers in their area for the care that they are seeking. By linking registries, additional improvements would be made to the system. For instance, by linking patient and provider registries, the patient registry could show the patient’s assigned primary care provider.

Another type of registry captures facility information and provides a comprehensive directory of all facilities, including hospitals, physician offices, public health offices, long-term care facilities, and mental health facilities.

The disease registry is yet another type of registry. Some already exist in Canada, including the Canadian Coalition on Cancer Surveillance (CCOCS), Canadian Heart and Stroke Surveillance System (CHSSS), and the National Diabetes Surveillance System (NDSS). These existing registries would eventually be linked within the public health system and would be linked to the clinical databases of the EHR.

1.1.6 Requirements Gathering: Foundation for EHR Functionality

T0+15 Months

Requirements gathering and analysis for all the EHR functionality would begin at T zero and would continue for approximately 18 months in this implementation plan. As Figure 1 shows, the requirements gathering and analysis stage feeds into many of the EHR components. Although many components would not be released immediately, this stage is critical to determining the appropriate vendor and procurement strategies to be used

1.2 Phase II: Years 3–6

In this phase, EHR applications would come online, and patient data would be accumulated. Because the EHR is made up of multiple interoperable applications that share data, that data must be mapped and normalized across the applications. These tasks could be made easier by using interface engines, but data mapping and normalization and the testing of data maps would require significant resources.

Phase 2

- A. Appointment & Outpatient Resource Scheduling
- B. Centralized Patient Materials
- C. Consultations/Referrals, Text Notes
- D. Laboratory/Anatomic Pathology, Order Entry/Results Retrieval
- E. Outpatient Pharmacy Link/Pharmacy Order Entry
- F. Nationwide Rx Phone/Web Prescription Refill
- G. Physician Outpatient Medication Order Entry
- H. Ancillary Order Entry/Results Retrieval
- I. Diagnostic Imaging Order Entry/Results Retrieval

1.2.1 Appointment and Outpatient Resource Scheduling

T+6 to T+42 Months

When patient, provider, location, and consent registries are in place, they can be linked to an appointment and scheduling system. This will facilitate the scheduling of outpatient resources, such as outpatient visits, surgery, procedures, and imaging studies.

This model focuses on jurisdictional resource scheduling, rather than appointment systems for individual clinics or hospitals. This facilitates improved matching of patients and their needs to available resources, improving workflow and resource utilization. Jurisdictional appointment and scheduling would allow for the comprehensive collection of data such as average days to available appointment slots and average waitlist times. It would also facilitate data gathering on specialty mix requirements for geographical locations and facility over-supply or shortfalls.

The requirements analysis process for appointment and outpatient resource scheduling would begin at T+6 months, and last 6 months. It is assumed that the procurement process would take approximately 9 months, followed by approximately 6 months for implementation, and 3 months for testing. Once online, patients would be able to access appointment scheduling through a Internet portal. Clinicians, with their baseline PC and Internet access, would be able to review their own schedules online.

1.2.2 Centralized Patient Materials

T+18 Months to T+36 Months

When providers first gain access to a patient’s electronic health record, it is important that the record be at least partially populated with data. In this rollout strategy, patient data begins accumulating in the EHR several years before the providers start using the EHR routinely for patient documentation.

One mechanism for early population of patient data to the EHR is the use of a centralized, standardized library of patient education materials and handouts. Patients and providers would have access to a library of educational materials, expanding the functionality of a patient portal.

By centralizing these materials, significant cost savings would be achieved by eliminating the need for these materials to be developed at the facility level across Canada. Centralization would allow for the widespread distribution of evidence-based, standardized, updated materials. Although clinicians, facilities, and provinces could continue to develop and use their own materials, with time, the convenience and ease of accessing such a central database are likely to encourage greater adoption of the system. This type of centralized database could also serve as a repository for evidence-based ordersets, protocols, and rules to be adopted into the local software applications, again promoting the distribution of such materials.

Utilization of a patient education database would contribute to the creation of patient problem lists. Any given patient handout would be appropriate only in the context of a limited subset of clinical diagnoses. The provider would perform a keyword search on the condition for which he or she wished to download a patient handout. When the appropriate handout was located, the provider would be presented with a pick-list of possible diagnoses appropriate to that handout. Upon selecting the diagnosis, the handout would print to the provider's printer. The diagnosis, date and time, provider, and location would be entered into the patient's record. The act of providing the patient with value-added patient education materials would thus passively populate the patient's problem list and save the provider time.

The requirements analysis, procurement, integration, testing, and implementation for this capability would be accomplished within an 18-month schedule (T+18 to T+36 months), with rollout beginning as soon as the nationwide infostructure is online.

1.2.3 Consultations/Referrals, Text Notes

T+6 Months to T+42 Months

Concomitant with the rollout of appointment and resource scheduling, the ability to send and receive consultations and referrals would come online. All consultations and referrals would be entered into the system, and text narrative results would become available to all providers. Transcription services might continue; however, the final narrative text would be entered into the EHR, using copy and paste functionality, direct entry by the transcriptionist, or by scanning. The results of the consultation would be associated with the appropriate diagnosis, further populating the patient's problem list.

Through online registries, the name of the provider requesting the consult, the date of the request, and the nature of the consultation request would be linked to the patient's record. The coded diagnosis, the text of the consultation note, the name and location of the consultant, the date the patient was seen, and the date the referral document was completed would also be linked. Text capability would provide for other free-text narrative data, such as hospital discharge summaries and operative reports to be stored in the system and linked to the patient and their problem list.

1.2.4 Laboratory and Anatomic Pathology: Order Entry and Results Retrieval

T+3 Months to T+57 Months

Laboratory and anatomic pathology order entry would be implemented in a phased approach. Initially, paper-based orders would continue, but results would be available electronically to the

provider. This would allow for real-time viewing of lab results across the continuum of care. Once running smoothly, the provider order entry pathway would be turned on, and the provider would begin entering all laboratory and pathology orders into the system. Entry of a laboratory order would require the entry of a coded diagnosis, selected from a pick-list of diagnoses, thus further populating the patient problem list in a passive manner. The laboratory system rollout would include both inpatient and outpatient order capability.

1.2.5 Outpatient Pharmacy Links/Pharmacy Order Entry

T+6 Months to T+60 Months

In this step, all pharmacies throughout Canada would be linked to the Pan-Canadian EHR. Using order entry functionality, pharmacy personnel would enter outpatient prescriptions into the pharmacy system, and links to the patient's registry would allow drug and allergy checking. Medications previously entered into the system, even if through another pharmacy across the country, would be recognized by the system, and the patient's medication list would be passively constructed. Drug/drug interaction checks would be done as the new prescriptions are entered.

We recommend a strategy that brings pharmacists up on pharmacy order entry before physician order entry. Although transcription of written prescriptions into the computer by the pharmacist would not be ideal for the long term, we feel the short-term benefits of gradually introducing the physician to this capability justify this approach.

Through registries, the prescription would be linked to patient, provider, provider location, pharmacist, and pharmacist location. The system would also allow for better management of pharmaceutical inventories and facilitate depot volume pricing through volume purchases.

The timeline for outpatient pharmacy links and order entry runs concurrently with the nationwide prescription refill program and physician outpatient medication order entry discussed below. Requirements analysis for this stage runs from T+6 months to T+15 months. Procurement would be completed by T+24 months, and integration by T+33 months. After testing is completed at T+42 months, rollout would begin. The outpatient pharmacy sequence would be completed 18 months later at T+60 months.

1.2.6 Nationwide Outpatient Phone/Web Prescription Refill

T+6 Months to T+54 Months

When all pharmacies are linked, a telephone and Web-based prescription refill system would be implemented. By calling a toll-free telephone number or logging onto a dedicated Web site, a patient would be able to enter prescription information, make required payments by credit card, and receive refills by mail. This functionality would add another piece to the patient portal and the personal health record.

Although physician order entry would not yet be available, the clinician would have access to the patient's list of outpatient prescriptions, and refill authorizations could now be done online. With the availability of other clinical data, such as laboratory results, the provider would be able to

view such data in the context of the medication being prescribed. Physician renewal of a prescription would prompt the provider with a set of appropriate diagnoses that would further populate the patient’s problem list, date and time stamp the entry, and link the provider, medication, diagnosis, and location to the patient’s EHR. Drug checking would be done automatically in this process: drug-allergy, drug-drug interaction, drug-food, drug-disease, and dose-range checking.

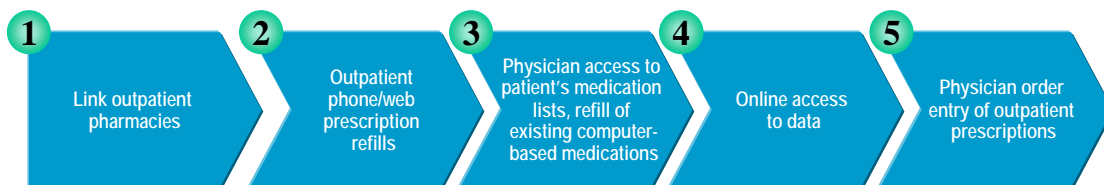
The requirements for this step are tied to requirements for the linked pharmacy system, and pharmacy order entry. Requirements analysis begins at T+6 months, procurement begins at T+12 months. Integration begins at T+21 months. After testing from T+33 months to T+42 months, the system would begin a 12-month rollout, ending at T+54 months.

1.2.7 Physician Outpatient Medication Order Entry

T+6 Months to T+60 Months

Pharmacy order entry has two user interfaces: one for the transcription of paper-based prescriptions by the pharmacist into the computer, the other for direct entry of the prescription order by the provider. Although the user interfaces may differ, the underlying data content, rules, and error checking share common pathways. The pharmacist pathway is activated first. When the pharmacist pathway is running smoothly, the physician pathway is brought online (see Figure 5). This incremental approach is intended to ease the transition for clinicians.

Figure 5. Incremental Approach to Physician Outpatient Medication Order Entry



In addition to providing alerts for allergies, drug interactions and dose errors, order entry applications should include calculators for determining body surface area, ideal body weight, pediatric dosing, unit conversions, glomerular filtration rate, and creatinine clearance and other important calculations. Ideally many of these calculations would be done automatically. Lifetime dosing with chemotherapeutic drugs is another desirable feature.

This step represents one of the major milestones of the EHR implementation, yielding some of the most significant financial savings and safety benefits that the EHR has to offer. The second comparable milestone comes in with inpatient order entry in Phase III. When this rollout is completed, benefits would begin to accrue in several areas: orders entered into the system would be linked with diagnoses, further populating and updating the patient’s medication and problem lists. Reduced transcription errors, and drug and allergy checking would reduce adverse reactions and the costs assumed with them. Reduced labor costs per refill would generate additional savings. Objective data about where and when drugs are needed would allow for better inventory control and depot pricing, and would strengthen the government’s hand in negotiating lower drug prices. Patients would experience reduced wait times at pharmacies. Association of diagnoses

with medications would allow early analysis of practice patterns, and might allow cost reduction strategies through use of lower cost alternatives while maintaining or enhancing quality of care.

Although the requirements gathering stage for this capability begins at T+6 months, physician order entry of pharmacy products would not be introduced to the field until T+48 months.

1.2.8 Ancillary Order Entry/Results Retrieval

T+12 Months to T+66 Months

This step would bring up order entry and results retrieval for all other inpatient and outpatient ancillary areas, such as physical therapy, dietary, the pulmonary function lab, EKG/treadmill, gastroscopy, audiometry, and so forth. Multimedia-based results would now be available through the patient's EHR, such as ECG tracings, digital retinoscopy images, still images from fiberoptic scopes, PFT flow-volume curves, and still images from cardiac catheterizations. This multimedia capability prepares the way for subsequent introduction of digital diagnostic imaging.

Physician offices, mental health clinics, and home health facilities would use electronic instruments to gather patient data and directly input the data into the EHR. Direct feeds of blood pressure, temperature, oximetry, glucometer, tympanometry, and readings from other common data instruments would be done automatically.

1.2.9 Diagnostic Imaging Order Entry/Results Retrieval

T+12 to T+66 Months

Diagnostic imaging order entry is deferred until this stage due to the technical requirements for handling the high-resolution images. At first, imaging centers would either digitize hard copy images or generate the digital images at the time of data acquisition or processing. Eventually, all images would be captured digitally. Digital images would require high-resolution displays for the radiologists to view diagnostic-quality images. Links from the imaging centers to the data storage sites would require significant bandwidth and sufficient storage capacity to handle large volumes of data. Store-and-forward mechanisms might be considered to transfer such large packets of data across provinces. Finally, access to the images at the point of care would require sufficient WAN and LAN bandwidth to allow access to high-resolution images without degrading the performance of other applications on the network. Local caching mechanisms would be beneficial in this regard.

The requirements analysis stage of digital imaging would begin at T+12, a time at which the As-Is performance characteristics of the baseline infostructure would be well known. During the 9-month requirements analysis stage (T+12 to T+21), clear definition of the delta between As-Is and To-Be performance and data storage requirements would be established, and would feed into the infostructure upgrade requirements slated to begin at T+36.

The To-Be requirements would become the basis for the imaging system procurement activity between T+21 and T+30. After integration and testing, the digital imaging capability would be introduced into the field beginning in month 48, early in the cycle in which wireless handheld

PCs and LANs are provided ubiquitously at the local level. This sequence and timing allow for the infostructure upgrade, and the capability requiring that infostructure, to coincide.

1.3 Phase III: Years 6–10

Once data is being collected and viewed, the ability to document care and the addition of more robust decision support would be layered on top of that data, bringing about Phase III. In this phase, “just in time” support would be brought to the clinician at the point of care. This decision support, combined with a rules engine, alerts, reminders, and medication

checking, achieves an additional reduction in preventable medical errors. With the ability to document care, all members of the care team would be able to view the care that has been given to the patient, increasing the quality of care, reducing duplication of services, and reducing the number of redundant patient questions. In addition, this phase introduces full outpatient and inpatient care documentation and case management.

Phase III

- A. Outpatient Encounter Documentation & Case Management
- B. Inpatient Resource Scheduling
- C. Inpatient Pharmacy Order Entry & Administration
- D. Inpatient Case Management & Documentation
- E. Specialty Units: e.g., Intensive Care, Cardiac Care, Trauma Care

1.3.1 Outpatient Encounter Documentation and Case Management

T+0 to T+84 Months

This stage would bring all systems to the third generation of functionality. At this stage, all the outpatient components would be assimilated in a completely electronic process. Complete outpatient documentation would be available to all practitioners via free text, template-driven documentation, and forms-based documentation. Using the national infostructure, via telephone modem or the Internet, the patient would be able to access the Canadian appointment system and request an appointment with an appropriate provider and appropriate facility.

The requirements analysis for outpatient encounter documentation and case management capability begins at T+0. The requirements elaborated for this capability informs the requirements analysis processes for all of the modules discussed in Phase 2. The 15-month requirements process would be followed by a 9-month procurement effort, from T+15 to T+24. We assume that a commercial system would be found to adequately meet the requirements for this module. To allow sufficient review of available commercial systems, including site visits and needs assessments, the procurement phase would last 15 months, from T+24 to T+39. It is assumed that integration of this standards-based commercial system would take 9 months (T+39 to T+48).

To allow sufficient time for workflow adjustments, change management efforts, and implementation, this module is assumed to require 3 years for complete rollout nationwide (T+48 to T+84).

1.3.2 Inpatient Resource Scheduling

T+6 to T+90

In preparation for bringing up the EHR throughout the inpatient environment, the initial effort would be focused on scheduling inpatient resources. This includes scheduling nursing and support staff, inpatient beds, procedures, and cost-intensive resources like operating rooms. The scheduling system would be interfaced with the order entry system so that tests would be performed at the appropriate times.

The requirements analysis for this capability would run from T+6 to T+21. Procurement would take 9 months (to T+30). Integration and testing would require 12 months and 9 months, respectively, ending at T+54, at which point the capability would be introduced to the field.

1.3.3 Inpatient Pharmacy Order Entry and Administration

T+12 to T+96

As noted earlier, inpatient pharmacy order entry represents a major milestone in patient safety and cost savings. However, inpatient order entry is much more complex than outpatient pharmacy order entry and is therefore deferred until Phase 3. Inpatient order entry includes intravenous and injectable medications, adult and pediatric hyperalimentation, admixtures, fluid management, and sliding scale dosing. It also includes orders for dosing or schedule changes dependent on the results of laboratory tests, vital sign values, and other key clinical parameters. Medication orders would drop into an electronic Medication Administration Record (MAR) and would be integrated with a bar-coding system. This process would ensure the “Five Rights” of medication administration: administering the right medication to the right patient, at the right dose, in the right route, at the right time.

1.3.4 Inpatient Case Management and Documentation

T+18 to T+102 Months

The capability introduced with this step completes the electronic documentation of all remaining “nonintensive” inpatient care, including Clinical Notes, flow sheets, anesthesiology, non-emergent operative and post-operative care, dialysis units, labor and delivery, nursery, and recovery room. Bedside telemetry, such as ECG, fetal monitors, and vital signs would be interfaced to the system, and components or subsets of telemetry data would be incorporated into the patient’s EHR. Documentation of all nontrauma emergency room care would also come online with this module.

1.3.5 Specialty Units: e.g., Intensive Care, Cardiac Care, Trauma Care

T+24 to T+108 Months

The final module of Phase 3 would bring online the remaining functions to fully support the intensive care areas, such as adult intensive care, neonatal intensive care, trauma centers, and burn units. Workflow in these areas can be complex, emergent, and unpredictable, frequently forcing documentation to be done after the care was given. Digital interfaces to ventilators, intracardiac pressure monitors, and arterial lines would be used throughout these areas to record patient data in real time.

1.4 Summary

At the end of the 10-year strategy, capabilities through all three phases would be in place. Patients would have a basic personal health record. Clinicians would be able to view results via an integrated clinical data repository, place orders, carry out e-prescribing, and e-communicate with patients and other clinicians. Decision support, alerts, reminders, rules, ordersets, and protocols would have markedly reduced the number of medical errors and improved the quality of care provided.

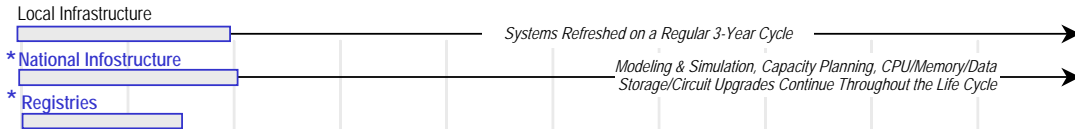
It is anticipated that various facilities would more or less follow this implementation plan, recognizing that benefits realized diminish, the longer it takes to come to this level of EHR functionality.

2.0 Alternative Implementation Strategy

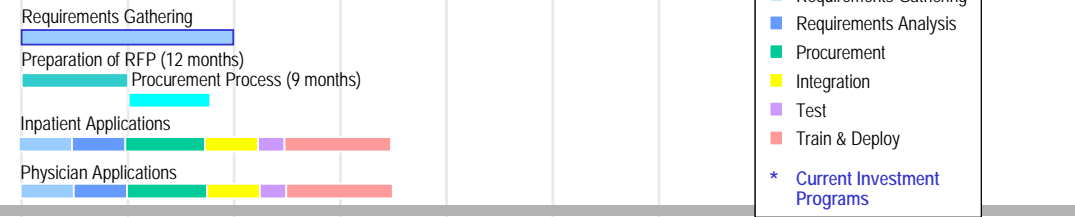
In keeping with Infoway's current investment strategies, Infoway asked Booz Allen to develop an implementation strategy based on rolling out EHR components and functionality in an incremental fashion. There is a recognized alternative approach to such a rollout, which would involve installing all components simultaneously in a "big bang" approach. Such an approach would likely result in even deeper mass procurement discounts from vendors able to provide all the components of an EHR. Although a rapid implementation would entail more "up front" costs, it also means that financial and quality benefits would accrue more quickly; and the cost of investment would be recovered over a shorter time span. Even though all functional components may be installed simultaneously, they may be activated sequentially so that training and change management can proceed at a pace that is acceptable to providers and other health care workers. Like the National Health Service (NHS) EHR initiative in the UK, where vendors were chosen by region, Canada's initiative could structure a procurement process as well by region. Although some components would be procured on a national level, such as registration, scheduling, and appointment systems, most of the software for the EHR would be purchased by region. The approach of installing an EHR all at one time naturally results in a different strategy around rollout. Instead of focusing on the incremental installation of components, this alternative strategy focuses on the care settings where the EHR implementation occurs. As noted above, this approach has different implications for both costs and benefits. Accordingly, we have adapted our financial model to estimate the costs and benefits of this approach.

Figure 6. Alternative Implementation

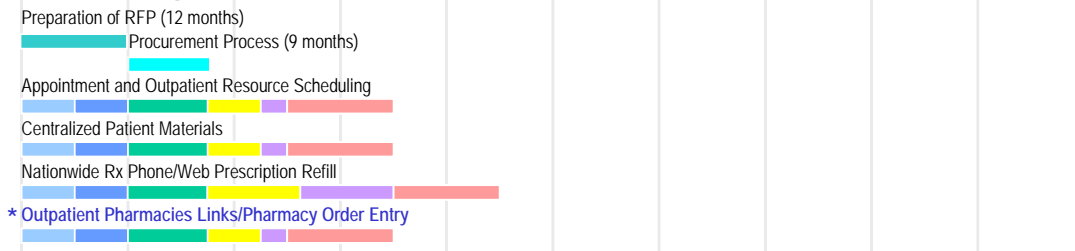
Infostructure



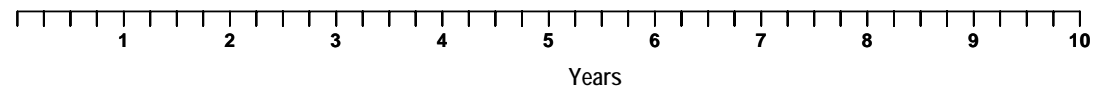
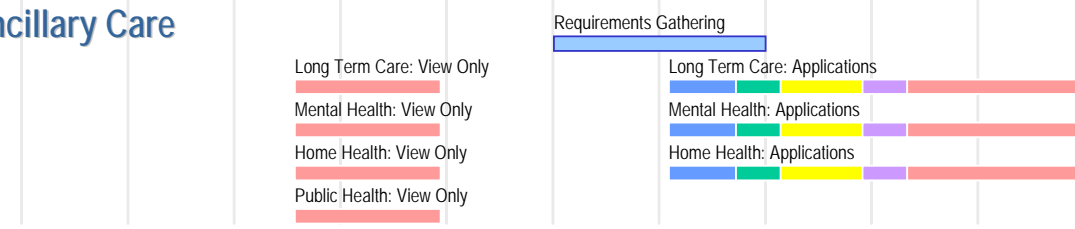
Inpatient and Physician Applications



National Components



Ancillary Care



2.1 Infostructure

This portion of the strategy remains the same as in the other strategy (see Figure 1). Local, regional, jurisdictional, provincial, and national infra/infostructure would be built in this phase. During this period, the regional and national infostructure, as envisioned by Inforoute, would be implemented.

2.2 Inpatient and Physician Applications

During this time period, the essential work involving requirements gathering and analysis for both inpatient and ambulatory care would be carried out. The applications to be acquired would be entire inpatient systems as well as ambulatory systems to provide for third generation capabilities. A request for proposal (RFP) for a mass procurement would be developed. It is anticipated that the RFP would be released at 12 months. Vendor selection would occur over the next 9 months, with vendor choices made at 18 months. Year three would complete work on requirements analysis, and a big bang approach to implementation would occur during years 3 to 5.

2.3 National Components

Several components of an EHR function best if procured and installed on a national basis. These areas are discussed in detail in Section 1, and they are as follows: appointment and resource scheduling, centralized patient materials, nationwide prescription refill program, and outpatient pharmacy links. Again, a period of requirements gathering would be carried out, an RFP developed, and vendor selection completed by 18 months.

2.4 Ancillary Care

Initially, view-only capability would be given to mental health, long-term care, home health and public health. It is expected that the dedication of resources to the implementation of inpatient and outpatient applications would not allow for the concurrent implementation of applications beyond these areas. In addition, allowing current niche solutions in these areas to mature so that they could be fully integrated into the inpatient/outpatient EHR would allow for a more powerful Pan-Canadian EHR. The view-only capability would allow providers in each of these areas to access critical patient information in a time in which applications could not be reasonably expected to be rolled out to these areas. A procurement process similar to that for inpatient and outpatient functionality would be carried out for these applications. At year 5, requirements gathering in these areas would occur. The RFP would be developed; and at year 6.5, the procurement process would be carried out. Again, this mass procurement would be expected to be carried out on the provincial level.

3.0 The Next 10 Years: a Vision for the Future EHR

In addition to seeking a recommendation for a 10-year Pan-Canadian EHR implementation strategy, Infoway has requested that Booz Allen present a vision for the “second 10 years.” This future vision is more speculative than the recommendations made for the first 10 years. During the first decade, we emphasized the need to implement EHR capabilities that currently exist. During the second decade, we also discuss capabilities that will mature and others that do not exist but are current or future developments. There are several categories of future capabilities that we will look at, including the enhanced capabilities of decision support, evolution of telehealth, and a more patient-centered focus.

As the EHR moves into the future, it will be transformed from a vehicle to capture and display clinical data, to a vehicle that is more interactive and specific to each member of the care team utilizing the record. Specific workflows of various specialties and ancillary departments will be incorporated into the EHR, making the review of patient data and carrying out clinical documentation more intuitive and easier for the clinicians.

Future Capabilities of Electronic Health Records

- Patient-centric care enabled by the EHR and PHR
- Powerful registries linking the patient, providers, facilities, scheduling, and disease registries with the EHR
- Embedded knowledge and robust decision support within the context of the entire patient
- Fully integrated ICUs and ERs that can be managed centrally
- Acuity monitors
- Telehealth available across the entire care continuum
- Integrated home health care
- Robust report and research capabilities
- Robust disease management systems
- Voice recognition and natural language processing as the foundation of clinical documentation
- Enhanced order management systems
- Workflow enhancements driven towards the unique qualities of individual medical specialties
- Long-term care, mental health and public health facilities fully integrated into the EHR
- Robust nationwide surveillance systems to track and anticipate disease outbreaks

3.1 Patient-Centric Care

The second 10 years will bring the EHR to maturity, leading to a robust, dynamic “partner” in health care that is truly patient centric. Patients will be able to view their entire record, enter data directly into their record with tags indicating it to be patient-entered. They will receive automatic health education materials, will be alerted when specific care is due, and will be able to update their own health histories. These health histories will automatically populate their EHR so that the clinician may review the patient entered information with no need to ask duplicate questions of the patient, and no need to enter that information themselves. This will make the visit more pleasant for the patient, and the visit itself more efficient.

3.2 Registries

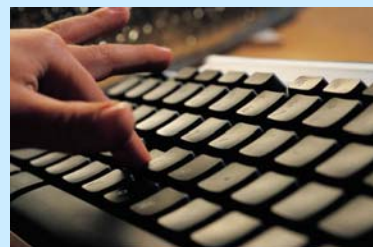
In time, registries will become more closely linked and their use more powerful. Patient inquiries into facilities and providers will become easier. Links between scheduling providers and facilities will allow for patients to choose a clinician and book an appointment at the same time. Disease registries will have been expanded to be able to track more conditions. By maintaining data warehousing capability, a snapshot of current clinical data, registries may be obtained real-time. Eventually, individual registries will become obsolete—the warehoused clinical data can serve as a master registry. For instance, a query to see the number of patients currently receiving radiation therapy for breast cancer could be performed. Rather than rely on such information to be reported, the information is captured automatically as a by-product of the patient’s clinical care. This capability will improve research capabilities, improve public health surveillance, and help in allocating resources.

Navigating the healthcare system of the future: Mrs. Turnbull’s story...

Mrs. Turnbull, who has recently relocated to Vancouver, BC, from Toronto, has a complex medical history, including chronic hypertension, depression, osteoporosis and a history of a left hip replacement. She is due for a visit to her physician and due for refills on her prescriptions.



Mrs. Turnbull goes online to her jurisdiction’s provider registry service, a “yellow pages” directory of all the health care providers within her region. From this registry, she is able to identify a clinician in her new area. She checks off a few personal preferences: male provider with interest in chronic hypertension located within 10 km of her home. The registry identifies Dr. Dubois, and she is able to read a brief biography about him. She is satisfied and makes an appointment electronically on a date and time convenient to her. She prints out driving instructions to Dr. Dubois’ office. Despite Mrs. Turnbull’s complex history, she need not remember the details of her past care: Dr. Dubois will receive an electronic synopsis of all of her care in a longitudinal fashion. In addition, Mrs. Turnbull keeps her own Personal Health Record up to date so that her medical history is current, limiting additional history taking from her clinician.



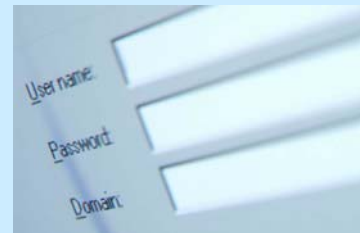
3.3 Decision Support

The greatest additional value to future EHR functionality will come via clinical decision support and will change the way in which we think about care delivery. Decision support will run continuously in the background to monitor a patient's care passively across the entire care continuum. This decision support will extend to the patient's own PHR so that alerts and reminders will automatically occur with patient initiated events. With the integration of biomedical devices, both those in the acute care setting and those used by patients in their homes, changes in the status of a patient will come to the attention of the care team real-time. Clinician support will be within the context of the entire patient and push to the clinician the most current evidence-based care appropriate to that patient. For instance, a physician caring for a patient in a diabetic coma is presented with the latest evidenced-based protocol for the diagnosis. The clinician will not need to search for the latest recommendations for care; those recommendations will be presented to the clinician at the point of care.

Likewise, a clinician will be able to view an up-to-date snapshot of the condition of the patient from anywhere and across any care setting. Continuously updated evidence-based recommendations, developed with the input of solid research, the use of multidisciplinary care support, and the passive tracking of outcomes, will all lead to a minimization of errors seen today and bring to healthcare a huge leap in the quality of care delivered to the patient.

Navigating the healthcare system of the future: Mrs. Turnbull's story...

In the process of making her appointment, Mrs. Turnbull is alerted that she is due for a mammogram and flu shot. She is able to make appointments for both of these, coordinated with her visit to Dr. Dubois' office. Because of her history of chronic hypertension, she is also reminded that she needs to continue checking a weekly blood pressure at home and recording that value into her PHR. As usual, she has the option to learn more about her chronic conditions either by linking to relevant Web sites or by printing out patient education information. Mrs. Turnbull has previously registered for a chat site with other individuals with depression, and she spends a few minutes chatting with this online community.



3.4 Clinical Documentation

Clinical documentation is an area that will see vast improvements over time. Today's clinicians are highly resistant to online documentation, as they perceive it to be more time consuming than either writing or dictating. In the future, Natural Language Processing (NLP) will be the way that free text documentation will be made structured. Clinicians will use voice recognition technology to dictate their notes. NLP will then be used to pull from the text needed data for applying rules and alerts, and coding information. In addition, data for research purposes could be extracted from the text. Thus medical errors will be reduced, fee-for-service coding will become a by-product of the care documented, and research will be improved.

Navigating the healthcare system of the future: Mrs. Turnbull's story...

When Mrs. Turnbull arrives at Dr. Dubois' office, the doctor's receptionist, Ms. Lee, greets her. Ms. Lee takes Mrs. Turnbull's Medicare card with her patient ID and swipes it through her system's reader. This automatically checks Mrs. Turnbull in for her appointment. Meanwhile, both Dr. Dubois and his medical assistant, Sue, are notified on their wireless handheld devices of Mrs. Turnbull's arrival. Sue is able to review Mrs. Turnbull past medical history and to review her PHR containing Mrs. Turnbull's own updated history. Sue notes that Mrs. Turnbull had had a cold in the preceding week, but that her home blood pressures have been stable.



Dr. Dubois records Mrs. Turnbull's history using voice-recognition software combined with Natural Language Processing. The visit is automatically coded and the documentation stored as structured documentation. The visit details are thus available immediately to other members of the care team who have appropriate authorization and security.

3.5 Integrated Pharmacies

By integrating pharmacies, the process of outpatient medication management becomes seamless. When this occurs, new prescriptions, refills, and renewals will take place easily no matter where the orders for those medications originate: hospital, physician's office, or refills from the patient's home. Guidance towards generic medications, appropriate medications, and the introduction of new medications will be done electronically. Patients will be able to order medications online and have them delivered to their home. For those patients taking medications for chronic conditions, automatic refill and delivery will help to improve compliance with taking with these medications.

Navigating the healthcare system of the future: Mrs. Turnbull's story...

Upon arrival to the pharmacy, Mrs. Turnbull finds that her medications are waiting for her. The pharmacy swipes her Medicare card to check for provincial eligibility for her prescribed medications and lets her know that there is a \$24 fee due for a non-covered medication. Additional information about her medications will be sent electronically to the patient via her PHR.



A week later, Mrs. Turnbull wakes up and logs on to her PHR. Her blood pressure is taken with an automatic cuff, populating her blood pressure directly into her PHR. The system has noted that her blood pressures, while in normal range, have clearly trended upward. An alert has been sent to the electronic triage box of Dr. Dubois. Mrs. Turnbull chats electronically with a jurisdictional nurse who follows an online evidence-based triage protocol in order to determine next steps. The triage nurse discovers that Mrs. Turnbull has had a very stressful week and missed 2 days of her medication. The nurse electronically sends information regarding relaxation techniques, offers Mrs. Turnbull an appointment to see her therapist, encourages her to exercise, and advises her to continue to take a daily aspirin and multivitamin. The jurisdictional nurse's task list automatically populates a task to check in on Mrs. Turnbull later in the day for follow-up.

3.6 Order Management

Order management will link results, diagnoses, and decision support. Dosages of medications will be checked against the key information about the patient; for example, not only looking at allergies, but also automatically checking that medication against such data points as the patient’s weight, age, gender, and kidney function. Ordersets, clinical care pathways, and protocols will be based on the latest evidence-based care and will include multidisciplinary orders that can be ordered together and routed to the appropriate department. Such orders will be presented automatically to the physician based on the context of the patient. For instance, if a radiologist diagnoses a patient with pneumonia based on a chest x-ray, appropriate orders will be presented to the attending physician, who may not have been aware that a diagnosis of pneumonia had been made.

When an order is placed at the point of care, it will generate additional relevant orders automatically. Thus in response to the order for a CT with contrast, a pregnancy test and creatinine clearance might be ordered if appropriate, along with the automatic scheduling of the test and the order to central supply for contrast material. Interactive task lists will be generated in response to orders for all members of the care team with flags for the more critical tasks, all of which helps to manage priorities in a logical fashion.

Navigating the healthcare system of the future: Mrs. Turnbull’s story...

A week later, Mrs. Turnbull falls at home, likely fracturing her right hip. She arrives at the hospital incoherent and unable to give a history. Because the emergency room department has access to her EHR/PHR, the care team knows the patient’s history, her medications, and her allergies. In the emergency room, a clinical care pathway is initiated that contains the latest evidence-based care for this diagnosis in the context of Mrs. Turnbull’s other medical problems. This initiates multidisciplinary care and directs care appropriate for her hypertension, depression, and her history of hip replacement. As part of the pathway, the nurse in the emergency room performs a falls-risk assessment. The documentation of a high score automatically sends alerts to the admission department that Mrs. Turnbull’s hospital room needs to be outfitted with a bed with rails; central supply is notified of the need for skid-free mats; nursing is notified of the need for frequent checks; the physical therapy department is alerted to the need for an assessment; the social services team is notified to begin planning for the patient’s home needs post-discharge; the lab is notified of needed lab draws; and the radiology department is notified of the need for a hip x-ray. The care team is able to spend time caring for the patient, care is initiated immediately, and time is not wasted on phone calls making such arrangements.



3.7 Specialty Areas

As the EHR moves into the future, it will transition from a vehicle to capture and display clinical data and documents and become a vehicle that is more interactive and specific to the member of the care team utilizing the record. Specific workflows of various specialties and ancillary departments will be incorporated into the EHR. Today, vendors offer specific workflow functionality around mental health, obstetrics, pediatrics, cardiology, oncology, critical care, surgery, operating room management, anesthesia, orthopedics, urology, ophthalmology, and dermatology, among others. Clinical data is presented in a fashion that is specific to a specialty. This advanced software makes reviewing patient data and carrying out clinical documentation more intuitive and easier for the clinicians.

In the future, the care team in hospitals will utilize passive tracking of patients. This will allow members of the entire care team to know where a patient is physically located, so the team will become more efficient with less time spent tracking down patients. For instance, a physician seeing his patients in the morning would know which patients were off the floor having tests performed and would not waste time searching for those patients.

Likewise in the emergency room, an electronic board will show the location of every patient in the emergency room, automatically updating as the patient is transported to various areas of the hospital. This board will indicate when new results become available and when new actions are due on each patient. Task lists automatically generated from orders will allow all members of the team to keep track of activities needed for all patients. In addition, the charge nurse will be able to view a task list for an entire floor so that it is immediately obvious when tasks are lagging and when personnel assignments need to be adjusted.

ICUs of the future will be completely integrated electronically so that vital signs, telemetry, ventilator settings, and intravenous drip medications can all be monitored at a central location. With decision support, subtle changes in a patient's condition will be detected far earlier than they could be noted in the paper world. Acuity monitors will evaluate the patient's condition continually so that the care team can easily note current conditions and trends of patient conditions real time. In this manner, more effective workforce management will be achieved. The nurse:patient ratio will be raised for more critical patients, while the more stable patients will have a lower nurse:patient ratio.

Navigating the healthcare system of the future: Mrs. Turnbull's story...

Mrs. Turnbull's attending physician notes on the emergency room tracking board that she has been transported to the imaging department for an x-ray. He then turns his attention to another waiting patient. When her x-ray is completed, it is immediately viewable electronically and reveals that she has indeed fractured her right hip. An electronic consult to an orthopedist is automatically generated from the diagnosis. All of the biomedical devices in the emergency room populate the patient's EHR automatically. Mrs. Turnbull's blood pressure can be trended with her historical BPs. Care is documented quickly via forms documentation, charting by exception.



The orthopedic surgeon evaluates Mrs. Turnbull, and a decision is made to take her to the operating room (OR). Post surgically, Mrs. Turnbull is admitted to the ICU. Her transition from the ER to OR to the ICU is seamless. Her nurses and physicians note all the events that have occurred in the emergency room and the OR, with immediate access to her lab results, x-rays, and response to her IV medications. There is no need for time-consuming signoffs between staff in different areas of the hospital.

The ICU charge nurse notes that Mrs. Turnbull's nurse has several tasks due on her activity list. This nurse has been tied up with a sick patient, and thus a less busy nurse is assigned Mrs. Turnbull's care so that her medications and interventions are delivered on time and are not overlooked. Mrs. Turnbull's ICU physician is able to adjust her intravenous medications from the centralized monitoring station, making necessary changes in a timely fashion. The acuity monitor reflects this, and Mrs. Turnbull's nurse is able to take on the care of another patient. When stable, Mrs. Turnbull is transferred to another unit, making her ICU bed available for another waiting patient.

3.8 Telehealth

Telehealth will develop in parallel with the EHR. In the future, it will transcend mere videoconferencing and remote evaluation of tests and images. Emergency rooms and ICUs in remote areas will be fully integrated so that a critical care clinician will be able to monitor all of the patient's vital signs, telemetry, ventilator settings, and intravenous drip medications remotely to give aid to local clinicians. Specialty consults will be given remotely. Telehealth will help to provide a similar standard of care to all patients, regardless of their physical location, thereby improving access to care.

Navigating the healthcare system of the future: Mrs. Turnbull's story...

During Mrs. Turnbull's second hospital day, she develops a diffuse rash. A dermatology consult is ordered electronically. The ordering physician is notified that the next dermatology consult slot is not available for 3 days, but there is a dermatologist with a telehealth opening in one hour. A camera is brought into Mrs. Turnbull's room, and images of her rash are transmitted real-time to the dermatologist. A contact dermatitis is diagnosed. The dermatologist enters his consult electronically, immediately populating her EHR with his findings. When the physician enters the diagnosis, a pick list of possible orders is presented to him; and he orders hypoallergenic sheets, hydrocortisone cream, and Benadryl.



3.9 Long-Term Care

In the future, all long-term care facilities will be connected to the Pan-Canadian EHR so that care in these facilities can be documented in the EHR. Thus the entire care team will be able to view the care given to the patient elsewhere. When patients are discharged from acute care facilities, their orders will be quickly duplicated and “transferred” to the long-term care facilities. This capability will allow for more remote management of stable long-term residents of these facilities. Physicians will be able to review nursing notes electronically and will be able to e-communicate with the team caring for the residents. Specialty consults will be carried out remotely with telehealth capabilities.

Navigating the healthcare system of the future: Mrs. Turnbull’s story...

Mrs. Turnbull is ready for discharge from the hospital and will go to a rehab facility because of her fractured hip. She is transferred to a long-term care facility.

At her temporary home, Mrs. Turnbull will not be expected to remember everything that happened to her while in the hospital; instead, this information will be available electronically to her caregivers.



3.10 Home Health

In the future, home health care will have greater capabilities. In the first 10 years, home health workers will be able to access a patient's EHR through a connection from their own laptops via phone lines. It is anticipated that cell phone capability will advance to a point where a home health worker could connect to the EHR via cell phone. At that point, tablet PCs will be the norm, allowing forms documentation of home visits to be completed quickly and easily.

Home health in the future will also enable more care to be brought directly into the home. Remote telemetry will be possible, allowing more patients with long-term care needs to be cared for in this setting. A home health nurse will be able to go into the home and conference by video with a physician concerning the next steps of a patient's care. Chronic disease management will be monitored passively in the context of the patient's entire care plan.

When care in the home is integrated into the EHR, the entire care continuum will be integrated into the EHR. Where patients physically receive their care will begin to matter less as the physical walls of facilities become less relevant. Care given in the office, at home, in the hospital, or in a long-term care facility will all become viewable across the entire care continuum.

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Mrs. Turnbull is discharged home. Here she has a home health nurse who visits her daily to monitor her blood pressure, her incision, her medications, and her rash. The home health nurse is able to view Mrs. Turnbull's care to date electronically, again, obviating the need to ask Mrs. Turnbull duplicative questions.



3.11 Surveillance

As surveillance systems become integrated with clinical databases, the ability for true population surveillance will be improved. Electronic communications systems can alert public health workers real-time concerning trends. Several patients who show up at different emergency rooms presenting a particular set of symptoms might signal the beginning of an outbreak of a disease. Today, vendors are developing software to monitor laboratory systems for unusual trends in abnormal lab results. In the future, this monitoring will be able to combine laboratory results and image and pathology results with diagnoses so that surveillance systems will be powerful.

Chronic disease surveillance will become more robust with the ability to carry out real-time queries on active diagnoses. As a clinical database becomes more robust with data, reporting and research become more valuable. In the future, reports will be generated in the background. Real-time research will be done. The need for expensive randomized prospective trials will be reduced. For instance, a real-time query could be made to evaluate the response to drug A versus drug B in ICU patients with a positive culture for *pseudomonas*.

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In the meantime, Canada's surveillance system has noted that across the country, patients on *Tensoride* with a diagnosis of hypertension and depression have experienced a statistically significant increase in their rates of severe depression. An immediate electronic warning is issued to clinicians and patients on the medication.



Dr. Dubois receives a list of his patients who have not acknowledged electronic receipt of the warning. From an original list of his 50 patients on the medication, there remain only three who have not stopped the medication and scheduled an immediate visit. His nurse contacts all three remaining patients on the list, discusses the new alert, instructs them to stop their medication, and schedules them for a visit. An otherwise onerous recall has taken a few moments to manage, rather than days.