

# ICT Convergence, Confluence & Creativity: The Application of Emerging Technologies for Healthcare Transformation

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## Abstract

*This paper outlines the convergence of ICT advances and their application to the healthcare sector. These advances arise from the confluence of events, tensions and needs identified by users - those who consume and provide healthcare. By working in partnership with end users, ICT solution companies are combining their expertise spanning health and information technology to meet these challenges. Examples of creative ICT solutions in health are discussed to highlight the importance of strategies that are clinically-driven, community-focused, and market-based. These user-focused strategies are critical to the uptake of ICT and are positioned as a radical departure to technology-driven approaches as a fix to complex health transformation challenges.*

*Keywords: EHR, ICT, mobile healthcare*

## Introduction

Canada's healthcare system is under siege. Traditional delivery practices are failing to meet the growing needs of our aging and growing population, resulting in reduced access to health professionals, longer wait times, more emergency department visits, and a reduced ability to avoid deaths from preventable causes. And yet spending is on the rise. Compared to other OECD countries that also have universal access and publicly funded healthcare systems, Canada spends more on healthcare than any other industrialized country except Iceland and Switzerland [1]. This accelerating growth in health spending is both unsustainable and unproductive.

This paper attempts to address the need for disruptive innovations in ICT to be applied to the healthcare industry to transform delivery for better patient outcomes and improved performance levels.

## Disruptive Innovation Theory

In order to realize the impact disruptive innovation can have on the healthcare sector there must be an understanding of what this concept entails. The theory behind the concept helps

explain how complicated, expensive products and services are eventually converted into more relevant (convenient), simpler, and/or affordable ones. Figure 1 demonstrates the performance of a product or service, which gradually improves over time. However, there are actually two different trajectories of performance improvement in every market, depicted in the graph by the solid purple and green lines.

### disruptive innovation theory

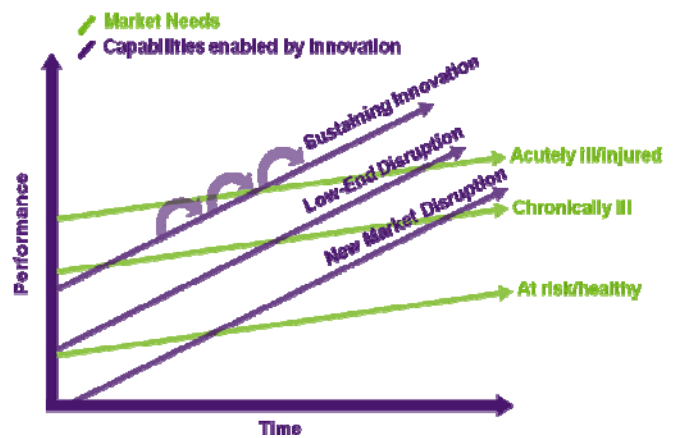


Figure 1 – Disruptive Innovation Theory

Described as sustaining innovations, the purple lines depict the continual improvement of a product or service that is introduced by companies over time. The green lines (market needs) follow a different trajectory: customers' demand for and usage of ever-improving products and services.

The points where the lines intersect represent the fact that companies upgrade their products with features more quickly than most customers can use them. And when products begin to have more functionality than customers need or desire, a different type of innovation occasionally occurs – a disruptive innovation [2].

### **Convergence: Enabling New ICT Capabilities**

Disruptive innovations can be described as products that are simpler to use, more convenient, and more affordable, enabling the participation of a new set of customers who were previously ignored by the market or shut out completely. Historically, ICT applications for the healthcare industry were largely inflexible, inelegant, and difficult to use. They were based on expensive, proprietary systems, requiring dedicated networks, and a specific type of device in order to access them. With the rapid advancements now taking place in the technology arena we are seeing the convergence of different technologies, systems, and devices into solutions that address the unique requirements of both the clinician community and healthcare provider organizations.

Driven by user need rather than technology itself, emerging ICT applications are being developed with open architectures that integrate data centers and networks for seamless access across the continuum of care. Built for fast, convenient access via the web, these applications can be used on a wide variety of multi-purpose devices and mobile technologies to optimize efficiency, provide critical information at the point of care, and ensure that care – whether delivered in the doctors' office, hospital, or in the community – is safe and effective.

### **Confluence: Creating Value through Integration**

Enabling transformations within healthcare requires addressing the changes confronting the delivery and consumption of care. The imperatives to improve quality, effectively manage health human resources, support

consumer-centric prevention and health management – all while driving down costs – are just a few of the challenges requiring solutions.

As mentioned above, Canada's population is aging. As a result we are seeing a rise in chronic diseases like Diabetes, Asthma, Congestive Heart Failure, and Depression all of which drive up the utilization of health services and increased costs. Chronic disease management requires the integration of information and care across healthcare clinicians and provider organizations. Unfortunately this is not happening due to a dependency on paper laden files distributed in various departments, across multiple locations, creating redundancies and communication breakdowns. The result is care delivery that is fractured and uncoordinated, often resulting in suboptimal quality and reduced outcomes. This failure in delivery causes patients with chronic diseases to increase their consumption of acute care; placing additional burden on parts of the health system, such as emergency departments, designed to deal with acute episodic rather than ongoing illness.

At Montreal, PQ, health establishments consisting of multiple providers are implementing ICT technology to integrate patient data across and between enterprises to give healthcare providers a 360° view of their patients' health record and status. Clinicians will have complete patient information from one source accessed by both wireline and wireless technologies. Electronic Medical Records for each patient are created, updated, stored and retrieved from one data repository via a common clinical viewer application available on all clinician PCs. This flexible application and framework has a number of interfaces to health related systems (labs, radiology, pharma) via HL7 V2.3, TCP/IP and various application vendor interfaces.

Emerging ICT applications, such as the Electronic Health Record, Health Data Warehouses/Clinical Repositories, Drug Information Systems, and point of care Clinical Tools, accessed via wireless technologies and devices will creatively address these challenges resulting in more effective patient care, increased patient safety and enhanced accountability across healthcare constituents.

## **Creativity: Necessity Drives Invention**

Nothing of significant value is created in a vacuum. Addressing current and emerging needs requires the combination of health and information technology expertise to define relevant strategies (that are clinically-driven, community-focused, and market-based). Disparate ICT applications need to come together and coalesce into innovative solutions to deliver the benefits of cost reduction, quality improvements, increased capacity/throughput, reduced wait times, and enhance user and patient satisfaction.

An excellent example of coalescence can be found in the way consumers are using ubiquitous technologies to participate in the management of their health. Utilizing wireless devices such as the iPod or Blackberry, consumers are accessing Web 2.0 social networking and health portal sites to research applications ranging from mobile personal fitness training to holistic health tips. This will empower consumers to take greater control of their personal health status and may positively impact disease prevention.

Applied creativity is at the forefront of disruptive innovation in healthcare. This requires bringing knowledge from all parts of the healthcare spectrum including those operating at the state, organizational (e.g., hospital) or community levels.

As disruptive innovations take hold new disruptive models for care that attempt to deliver value that is distinct from those of hospitals and physicians will begin to emerge. They will focus on specific, rules-based portions of healthcare delivering care at lower cost and with higher quality than traditional models.

With new disruptive models of care, the healthcare system will see improved physician productivity, better utilization of scarce nursing resources and patients would continue to receive high quality care but at a lower cost to the system.

### ***Clinical Use Case***

When the Department of Health in South Australia identified the need for an enterprise-wide, patient-centric clinical information system to provide clinicians with access to cumulative patient information at the point of care they knew that a variety of clinical applications which provide an electronic health record for patients being admitted to the major public hospitals was

required. The objective of the project was to revolutionize the way information is stored, distributed, and accessed in the South Australia healthcare system comprised of eight major metropolitan hospitals located in the capital city of Adelaide [3]. This healthcare system services 75% of the state's population of 1.5 million.

Four specific drivers were identified by the South Australian Department of Health as key to the development of the resulting Clinical Reporting Repository (CRR). They were:

- **Clinical Decision Support.** To facilitate better informed clinical decision-making and patient care
- **Clinical Research.** The development and evaluation of protocols, treatments, and drugs
- **Productivity Improvements.** Automation of reporting processes and enhanced reporting capabilities
- **Single Data Repository.** The volume and content of this part of the solution made the reporting potential impressive.

The CRR consists of a number of datasets comprising patient demographics, provider details, orders, results, location, and encounter information associated with a specific clinical event. For example, information is captured about patients, their admission history and demographics, the admitting doctor, ward and clinical unit, the test and procedures ordered and result for those procedures such as pathology results, radiology reports, and dialysis information.

As for ease-of-use, convenience, and enabling the participation of a new set of customers, the Clinical Reporting Repository (CRR) gives non-technical users the capability to input, query, analyze, and explore substantial clinical data from a variety of wireless and mobile technologies to improve safety and quality outcomes for patients.

As at December 2005, the CCR holds approximately 1.3 billion clinical information records and grows by approximately 900,000 records per day. Today, similar systems are being used at MUHC/CHUM here in Montreal. The introduction of these inpatient applications along with wireless migration to fourth generation Long Term Evolution Network Technology (4G LTE) allows for dramatic changes both for inpatient and citizens in the community. New portal capabilities are feeding health consumer demand

for richer content and contact with health providers – in the coming years, hospitals will be leveraging wireless networks to communicate with patients securely via mobile patient portals.

### ***Mobile Solutions for Community Care***

[4] There is a growing reliance on home care and community care as a result of rising costs for acute health care, longer wait times, and the desire to enhance the quality of life by helping patients become more independent. Because the community care workforce is mobile, they require ICT tools that enable them to communicate with their patients and other health care providers both efficiently and effectively in real time.

To satisfy this need, a solution incorporating an end-to-end browser and mobile-based service that includes device, network, and application has been created and is being implemented in communities across Canada. These solutions are based on service-oriented architecture (SOA) and built on industry standard HL7 v3 [3].

Using a laptop, tablet, PDA, or smart phone, caregivers have access to a full electronic health record and patient management system which makes patient data available to them at the point of care. Devices can be selected to meet the specific needs of the organization and users, allowing the same mobile solution to be run on different device types simultaneously.

Updates can be made to care plans, test results can be accessed, and clinical processes reviewed at the time of patient care. With this information, informed, real time decisions can be made to respond to a patient's needs. Updates and information can then be shared across the continuum of care with other healthcare providers through wireless synchronization. By employing standardized processes and workflow tools, the result is improved patient outcomes, more productive communications and better evidence based practice for practitioners .

### ***Mobile Wound Care***

The application of mobile community solutions is demonstrated in community-based wound care solutions. Wound care can account for up to 40% of in-home visits conducted by home care providers. Due to the diversity in types of wounds, treatment options, and healing rates, health care providers need to have the ability to remotely consult with wound specialists and implement the treatment at the point of care

To accommodate this, front line care providers are equipped with handheld devices that enable them to assess patient wounds, access and update wound care visit forms, take colour digital photos of the wound, and transmit the information in real time from the point of care to wound specialists any where in the world via a secured mobile connection [5]. If the wound requires immediate attention, as based on a set of criteria established by the wound specialist or the agency involved, a call would be placed alerting the wound specialist who would access the information via the Internet and prescribe a treatment protocol. This application brings care to the patient, reducing discomfort and costly travel to a clinic or hospital, and improving average healing time.

Clinical benefits include:

- Improved accuracy of diagnosis
- Reduced healing times
- Avoidance of unnecessary surgical treatment
- Reduced length of stay at acute care site
- Patients with delicate wounds do not need to leave their homes

Administrative benefits include:

- Measurement and tracking of effectiveness in wound care treatment
- Enhanced access to scarce specialized resources
- Decreased travel time for care providers and patients
- Decrease time spent on data entry
- Reduced costs while increasing productivity

### ***Mobile Applications under Development***

In the very near future Canada will see the introduction and adoption of an Internet-based medical appointment scheduling system with related medical information incorporated into the solution and readily available. It can be securely accessed from anywhere using any device using the Internet; providing for efficient scheduling and coordination of appointments, medical equipment, tests and facilities. It can also be extended from conventional scheduling and reporting to enhanced clinical support in the form of telemedicine, distance education, and disease and case management.

The system is fully compliant with Canada Health Infoway standards. The platform can be implemented to support a single service or multiple activities across one or more departments, an enterprise, or various unrelated

clinics and facilities, seamless integrating into mainstream healthcare delivery models and operations.

With the new scheduling system there will be shorter wait times to see scarce specialists or to undertake needed medical tests. And faster diagnosis enables better patient outcomes.

### ***Emergency Room***

The hospital emergency department is rapidly becoming the most over-burdened area in healthcare today. Over-crowding, increased wait times, many more ambulance arrivals, and a lack of resources are all contributing to increased workloads and stress levels for clinicians. At the same time hospital administration is looking for ways to reduce costs and improve productivity without compromising patient safety.

ICT applications including ER tracking systems and integration with EHRs facilitate better clinical decision making. Outcomes are improved because the clinician at the point of care has a complete view of a patient's record. Traditionally, the clinician had to rely on paper based files which take time to locate, may not be accurate and up-to-date, or may be located in an entirely different hospital. The only way to help was to rely on the patient's memory often during a crisis. EHRs provide the ability to build-in clinical decision support, incorporating local clinical guidelines and other clinical best practice models, linking knowledge to the patient's profile, thus ensuring more optimal care.

Such clinical best practice models will not work unless broader EHR solutions are utilized to support decisions at the point of care such as in an emergency room. This is being achieved in the province of Newfoundland and Labrador by linking complete patient drug profiles (all drugs, all people) between hospitals, physicians, and pharmacies.

The province of Newfoundland and Labrador has identified both clinical and financial benefits that will be achieved by implementing a provincial Drug Information System within their Pharmacy Network. This system will give pharmacists and care givers access to a secure repository of patient medication profiles, and a comprehensive set of tools to facilitate viewing and analysis in support of patient care [6].

The primary functions of the Drug Information System are:

- e-Dispensing and e-Prescribing
- Drug Utilization Review (DUR)
- online access to drug profiles
- drug search and look-up; and
- online clinical decision resources

All healthcare providers will communicate with the Drug Information System through HL7 version 3 messages. This includes pharmacists in public and private pharmacies, physicians in clinics and hospitals, and other providers in a diverse variety of settings - such as nursing stations, homecare, etc. To enable this, the system interfaces with existing point-of-service systems (Pharmacy Practice Management Systems, physician Clinical Management Systems, Hospital Information Systems, etc) and can also be accessed using secure portal technologies. System roll-out begins in early 2009.

The Drug Information System in Newfoundland and Labrador is the foundation of their Electronic Health Record - which places the patient at the centre of both the traditional and 'electronic' health delivery system. In Newfoundland the targeted benefits of EHR are:

- reduced wait times,
- better coordinated care,
- improved health workforce capacity, and
- reduced medical errors.

Initial realization of these benefits as they apply to the Drug Information System is expected to start emerging in middle to late 2009. A study by global consultancy Booz Allen Hamilton estimates that EHRs would save Canada's health system \$82.4 billion in health costs over the next 20 years by:

- Reducing adverse drug reactions by 29 million incidents, saving \$48.3 billion
- Reducing unnecessary radiology tests, saving \$3.6 billion
- Reducing unnecessary laboratory tests, saving \$10.5 billion
- Allowing the substitutions of cheaper alternative medicines, saving \$20 billion

The benefits of linking drug profiles in hospital settings were assessed at MUHC in Montreal. Computer-based accesses to complete drug profiles with alerts to physicians for any potential prescribing problems are expected to account for

reductions of up to 18% in inappropriate prescriptions [7].

### Discussion

According to an Ekos survey, overall, 85% of Canadians support the development of electronic health records as they strongly believe EHRs will improve the ability of healthcare providers to provide quality care [8]. Why? Because it represents one of the most obvious examples of how technology, intelligently and creatively applied can have a dramatic positive effect well above the investment required to create and deploy it. So not only do we have providers agreeing that the need for technology solutions is critical, but we have consumers of healthcare demanding it.

It is important to note that the quality of communications in healthcare can literally make the difference between life and death. There are as many as 24,000 patient deaths in Canada each year due to medical errors in the hospital setting, with additional deaths resulting from errors in the ambulatory and long-term care environment. Medical errors are the third leading cause of death in Canada, causing more deaths than HIV, breast cancer, and motor vehicle and transport accidents combined [9]. Paper-based systems have a higher probability of mis-identifying a patient, thus adding a new dimension of risk. ICT applications, like the EHR, drug information systems and a range of mobile devices are used to enhance the interaction between patients and providers. A new standard of interaction will allow improvements in the quality of care and safety of patients within the institutional and community settings by reducing medical errors caused by illegible handwriting and by detecting dosage mistakes.

### Conclusion

This paper emphasizes the need for disruptive ICT innovation in the Canadian healthcare system to tackle our most serious challenges.

By creatively applying emerging technologies to address the needs of providers and users of healthcare we can benefit from increased productivity, enhanced clinical decision making, and increased access to home and community care.

Emerging technologies will transform current practice by providing:

- Better information at the clinician's fingertips
- Better information sharing across the continuum of care
- Flexibility to respond to new system, provider, or patient needs
- Increased provider productivity by working smarter, not harder
- Costs savings
- Low training requirements
- Security
- Analytics to support both management and research

The result will be a more affordable and sustainable health system now and for future generations.

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