A Conceptual Framework for Innovative E-Healthcare System

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Abstract

Information Technology (IT) is a critical resource for improving today's business competitiveness. Embracing e-healthcare and treating IT as a strategic tool to improve patient safety and the quality of care enables healthcare professionals to benefit from technology formerly used only for management purposes. One of the dynamic forces in research is a conceptual framework that conveys researchers with the foundation upon which their studies are fabricated. This paper instigates with a definition of E-healthcare innovation and an understanding of how innovation occurs in healthcare. A conceptual framework is then developed which articulates the intervening variables that drive innovation in E-healthcare.

Keywords: E-Healthcare Innovation, Information Technology, Healthcare System

1. Introduction

Health care organizations are knowledge-intensive, and the need for professional development and innovations is essential. Rapid changes in treatment techniques, pharmaceutical products and legal requirements necessitate an ongoing professional development [1]. Innovations in health care organizations could be *e.g.*, new treatment, new work practices and quality improvement as well as the introduction of new information systems. These innovations differ in degree of complexity.

A healthcare system is much complicated and comprehensive as it involves many aspects from hospital management to staff tracking. We focus particularly on patient record manipulation, as even this concentration is sufficiently complex to provide a comprehensive analysis of data, database design, and implementation steps.

Advances in medical technology and connected devices are also changing the physical environment at home. Innovations like electronic pills that track medication compliance, sleep monitors, personal electrocardiogram devices and other standalone digital sensors create a bridge between individuals and healthcare professionals, providing flexibility of care and greater insight into patients [2]. Affordable and user-friendly telehealth platforms and in-home monitoring devices will make in-home patient monitoring the norm, allowing remote caregivers to be notified in real-time of any incidents and improving access of healthcare services to regional areas.

The increasing use of electronic medical records in acute care opens an alternative to evidence-based practice for clinicians when the evidence doesn't exist. Randomized controlled trials giving rise to evidence-based practice remain the gold-standard, but there are innumerable instances where – for ethical reasons, due to the rarity of the condition, complex co-morbidities or in pediatrics' – research hasn't been undertaken. Data analytics is opening up the information stored in the unstructured clinical notes, deep within the

medical record, to allow clinicians to draw conclusions on the best treatment for their patient when there is no published best practice.

E-Healthcare is widely accepted as an option for improving health services and information. E-Healthcare is defined as the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including healthcare services, health surveillance, health literature, and health education, knowledge, and research. As E-Healthcare spreads globally, questions about its feasibility and impact need to be addressed. Health systems must evaluate e-health in relation to factors that affect its use at different stages of implementation. Different factors that play important roles in development, implementation, and operation of E-healthcare must be understood and evaluated. This study analyzes different theories of evaluation applicable to e-health to obtain a better understanding of factors related to E-healthcare and those stages of application they are most likely to influence.

2. Related Works

A deliberate and unique framework is required to support innovation in healthcare. Organizations in the health sphere are often wary of traditional innovation approaches (i.e. 'safe to fail') due to the direct impact their actions have on human health and lives. However, understanding the potential opportunity cost (*e.g.*, lives, length of stay, and available beds) can help drive an appreciation of the significant benefits that could be obtained from embracing a pragmatic innovation framework [3]. The framework needs to allow for the exploration and incubation of new ideas, and the ability to experiment with emerging technology to implement innovative solutions; all while appropriately managing risk and overcoming traditional roadblocks. Many different models can be followed when establishing an innovation center. Often these physical centers are created as a center of gravity for innovation. Clear goals and objectives must be used to inform the type of environment created. Regardless of the model, healthcare providers need clear focus areas within the center, and a strategy for what happens to successful proof-of-concepts, and how are they funded and transitioned into full-scale implementation.

The conceptual framework for this study has been developed through a literature search of different theories and concepts on evaluation of e-health and a process of iterative review of this literature by several users of E-healthcare.

2.1. Healthcare Levers

Healthcare and life sciences are facing major challenges – technological change with vast disruptive potential, a constrained funding environment, changing population needs and consumer sentiment all create drivers and opportunities for transformation in the industry and adjacent markets (*e.g.*, aged care and smart home solution providers) [4].

The fundamental problem is how to sustainably deliver high quality, accessible care to the people who need it at the right time, in the right place and with the right intervention. Solutions that have worked well in the past, like reducing length of stay and increasing workforce productivity, are not sufficient for this challenge. However, new technology, service and business models create the opportunity to influence the demand, utilization and supply levers outlined below.

Figure 1. Healthcare Innovation Factors

2.1. Information Flow in the Health Care System

The Figure 2 shows a characteristic information flow in the healthcare system. Patient health records could serve a range of purposes apart from diagnosis and treatment provision. For example, information could be used to improve efficiency within healthcare system, drive public policy development and administration at state and federal level, and in the conduct of research to advance medical science. A patient's medical records are also shared with payer organizations such as insurance, Medicare or Medicaid to justify payment of services rendered by physicians [6]. Healthcare providers may use records to manage their operations, to assess service quality, and to identify quality improvement opportunities. Furthermore, providers may share health information through a regional health information organization to facilitate care services. Medical information of patients is also used for common good through federal and state government interventions regarding public health management, hospital accreditation, medical research, and for managing social and welfare systems.
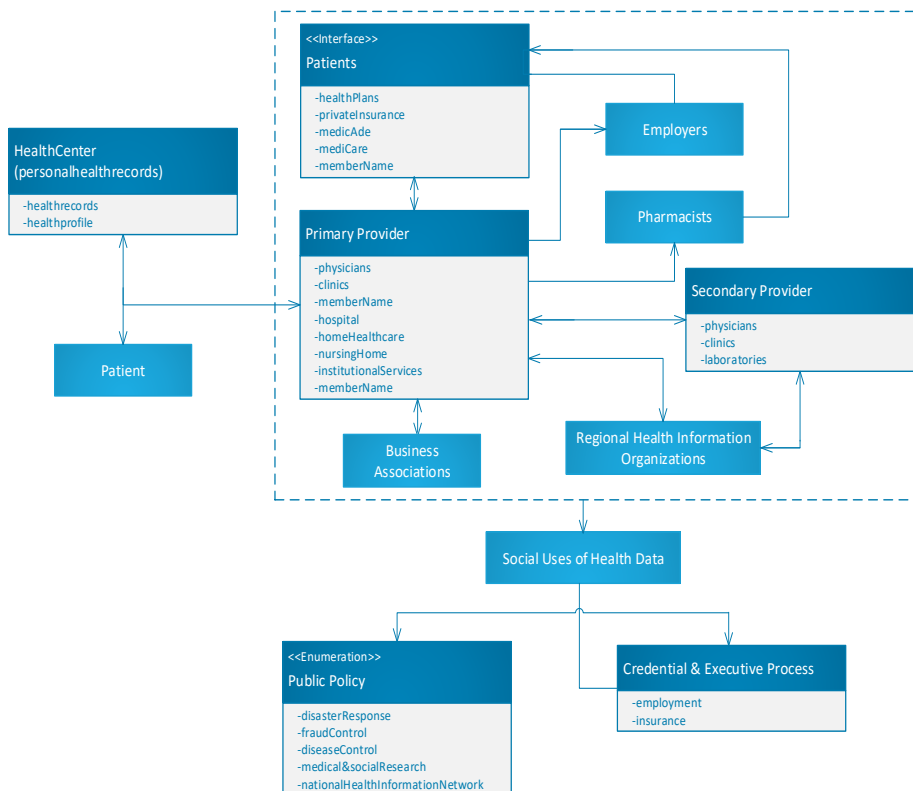

Figure 2. A Graphical View of Information Flow in the Health Care System

2.2. The Process of Healthcare Innovation

Many of the innovations in healthcare have been initiated by the healthcare stakeholders (patients, patient advocacy groups, healthcare organizations, physicians, other healthcare professionals, *etc.*,) In some cases, the need for change is forced upon the healthcare organizations by the government in an effort to mitigate healthcare concerns and challenges [8]. Once the need is identified, the next challenge lies in determining whether the need can be met internally or by a healthcare innovation company. If the innovation originates from within the healthcare organization, it is tested, modified and adopted. If it does not originate from within the healthcare organization, the need is instead met by a healthcare technology company that develops tests and markets the technology to healthcare organizations. In certain cases, a healthcare innovation company takes what might be an imperfect attempt at innovation from a healthcare organization and refines it into a better product, and then markets it to healthcare organizations. It is important to understand the internal process of innovation within a healthcare organization such as a hospital, nursing home, home health, or managed Care Company [7]. These organizations typically do not have the luxury of a huge research & development department, and so must rely on the raw talent and creativity of internal staff and work teams. As Figure 2 illustrates, a managed care company may rely upon the feedback from its sales and marketing field staff; a hospital might rely upon feedback from patients, physicians and staff; and both groups may rely on information regarding competitors in order to commence the search for improvement. In some cases, the limitations in the resources available to the healthcare organizations force them to partner with a healthcare innovation company to create a product that meets their needs.
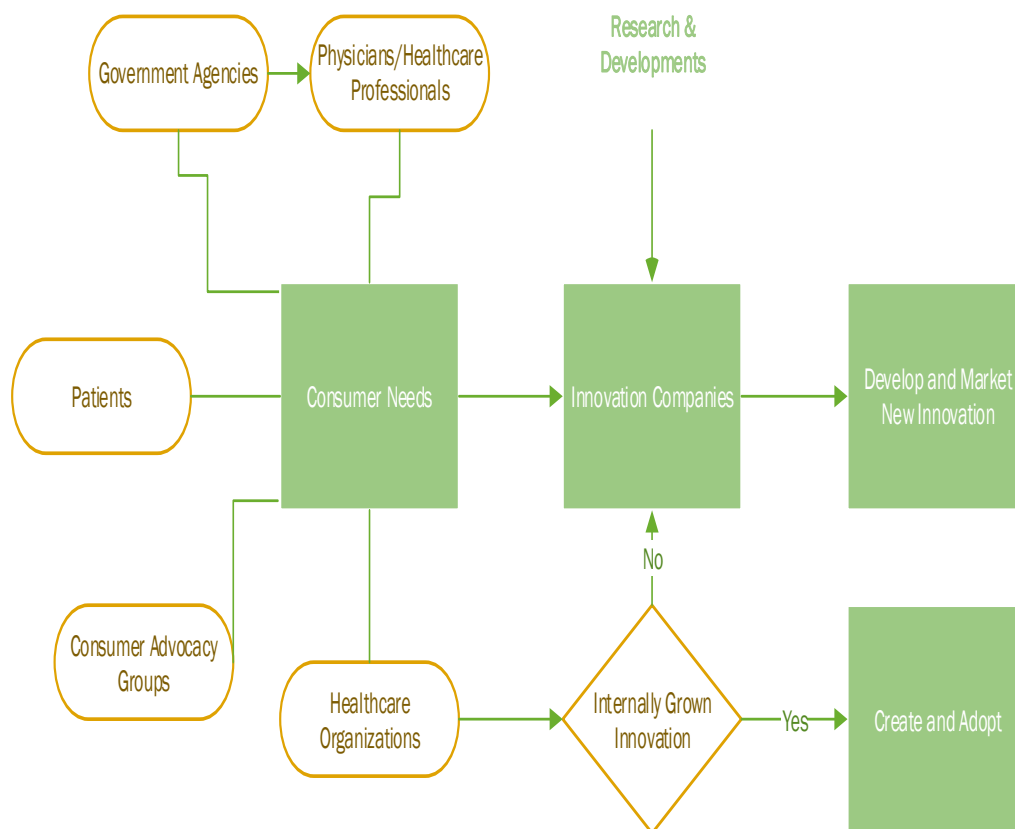

Figure 3. The Process of Healthcare Innovation

2.3. The Dimensions of Innovation in Healthcare

There are two principal dimensions of healthcare innovation – Organization and Physician acceptance dimensions. These dimensions motivate or affect the introduction of innovation in healthcare organizations [9]. The Organization dimension includes the enhancement of clinical results, proficiency, success, aging population, nursing shortage, patient satisfaction, profitability, patient safety, improved quality and cost containment. The Physician dimension includes physician acceptance, organizational culture, regulatory acceptance, and partnerships and collaborations. Figure 3 below shows the factors.

Figure 4. Environmental and Operational Dimensions of Healthcare Innovation

3. Conceptual Work Products in Health Care and Health IT Design

Conceptual work products are a part of domain models that have been under recognized in popular design methods. They are the entities that conceptual work activities operate on to transform them to their goal (product) state. Our workflow studies have shown conceptual work products have fundamental importance in clinical care as diagnoses, plans for contacting patients, treatment plans, and schedules for using equipment and facilities. These are key information objects of health care work but they have no manifestation in the material world until they are acted on, making them vague and difficult to define clearly.

Conceptual work poses problems for health IT support. In comparison to tangible work done in the physical world – work that is overtly observable – the nature of conceptual work is not as evident. An additional complication is that the knowledge about conceptual

work may be distributed over multiple human and machine resources. Information systems are actually carried out not only by computers but also by the manual and cognitive activity of clinicians. As they interact they must transform the conceptual work product into its goal state or the system will fail. A key risk of failure arises if developers cannot specify the product of conceptual work that their system is supposed to accomplish.

In the terminology of knowledge representation, a conceptual work product is a declarative model that emphasizes what the system must create in a manner that is independent of how it will be created. A model of the conceptual work product represents the work requirements of a domain independently of particular technologies or processes to accomplish them. We will illustrate how conceptual work products can be modeled as class and state diagrams that include a clear description of a valid starting state, a valid ending state, and intermediate states that describe acceptable transformations of the product. These essential requirements also provide a reference model for the information architecture and important content of the user interface. An important role of the user interface is to inform the user of the state of the work product in order to decide the user's next actions.

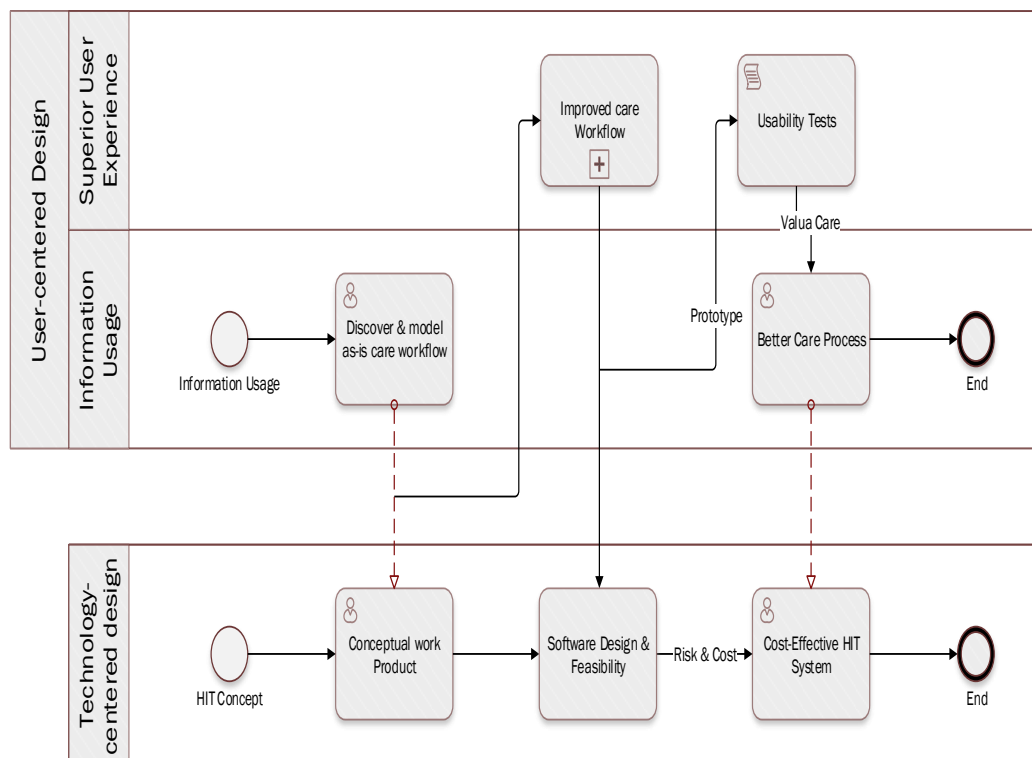### 3.1. The Conceptual Work E-Healthcare Care Delivery System

Figure 5. Method for IT-Based Healthcare

This method Figure 5 combines conceptual models of work products with procedural models to design better health IT. In this section we describe an important limitation of procedural models (*e.g.*, workflow models), and describe how conceptual models can complement procedural models to overcome this limitation. Workflow modeling languages such as Business Process Modeling Notation (BPMN) represent transactional work using the format of a directed graph [12]. They provide a key capability to document how the activities of care are actually done and allow us to analyze how they can be improved. Workflow connects health IT to better care. However, these graphical models lose the advantages of visual representation when they become too complex. This

can occur when trying to model work that is conceptual in nature and depends substantially on tacit knowledge. Case management is an example of conceptual work. A case manager may aim to identify patients whose treatment plans are not progressing, discover the reason for the delay, and decide whether and how to intervene. It is not practical to represent all this decision-making as a workflow because the combination of factors and contingencies is very large. For example, the case manager in this study described several tasks she may perform simultaneously when she receives a phone call from a patient. They include conversing with the patient, taking notes on paper to document the phone call, accessing the patient's electronic health record to review current orders, and making judgments about the best course of action to take with the patient. Additional tasks depend on the reason for the call. If the patient is calling about a ''flare up'' in the patient's MS symptoms, the case manager may direct the patient to the emergency room, but this depends on the severity of the symptoms. If the patient is calling to check on the status of a shower chair that they expected to receive, the case manager may conclude the call, identify and contact the person responsible for ordering the chair, and call the patient back to update them on the status of the order. Within each of these scenarios, the tasks could be different based on urgency, and they may occur in different sequences. In addition, a patient may call about more than one of these scenarios at once, further complicating the nurse's decision-making. Modeling all possible combinations of these scenarios and activities can quickly become impractical, both for creating the model and relating it to IT design.

3.2. Framework for Change

A considered and unique framework is required to support innovation in healthcare. Organizations in the health domain are habitually guarded of customary innovation methodologies due to the uninterrupted influence to their actions on human health and lives. However, understanding the probable opportunity cost can help drive an appreciation of the substantial benefits that could be obtained from embracing a pragmatic innovation framework. The framework needs to allow for the exploration and incubation of new ideas, and the ability to experiment with emerging technology to implement innovative solutions; all while appropriately managing risk and overcoming traditional roadblocks.

Working out how to deliver high quality healthcare to more patients with different and more complex needs and less funding, while responding to broader market disruption and consumer expectations, is a significant challenge for the entire healthcare industry. It requires a vision and actionable strategy that considers the conscious trade-offs that need to be made on relative focus areas, change initiatives and capabilities.
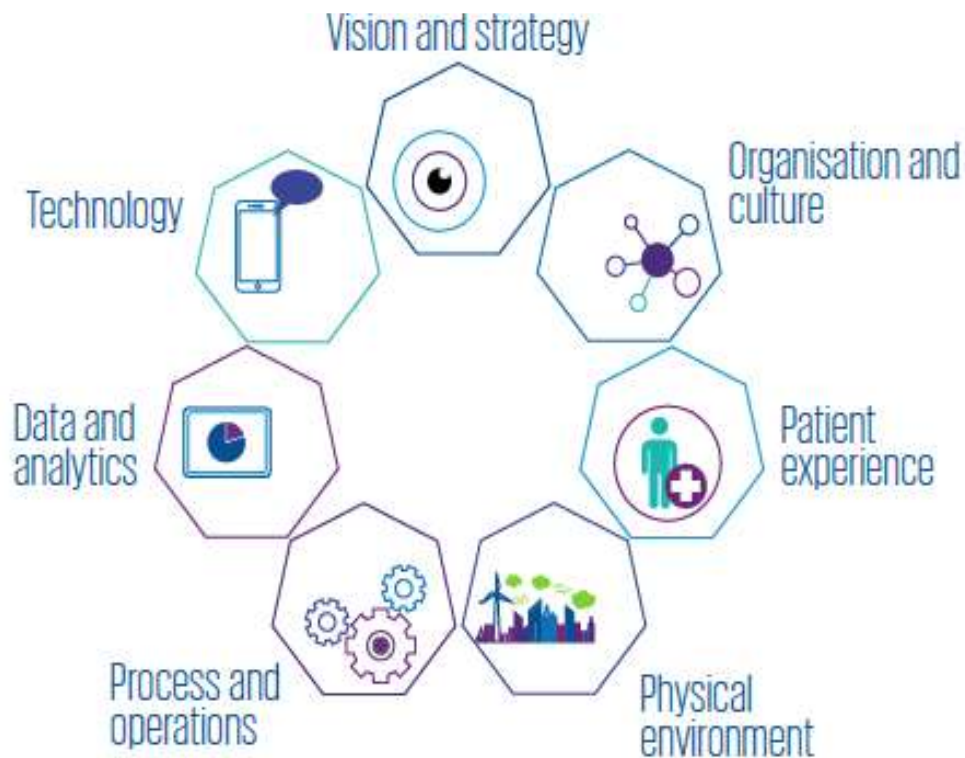
Figure 6. Framework in Supporting Innovation for Healthcare Organization

While there is no one path to success, there are a number of common elements in cohesive strategies:

1. A point of view regarding the likely future state healthcare operating model
2. How you intend to operate in the future and rationale (*e.g.*, how and where to provide services to meet demand; new markets and services)
3. Outlining key success factors and capabilities required to be successful in the desired space
4. Investing in innovation and promoting a culture of pragmatic innovation.

3.3. E-Healthcare Process Workflow

Information systems help reduce the rate of errors in the medical industry. Implementing IT in the manufacturing industry has allowed many firms to adopt a 'zero defects' policy. When faced with increasing malpractice insurance costs, healthcare providers should also turn to IT for help with improving quality care and patient safety. An effective information system should track patients throughout their tenure at a medical facility, reducing errors in the treatment process. Ideally, no errors should occur – the physicians should be empowered with all the necessary knowledge thereby preventing the occurrence of adverse events. Unfortunately, this is not realistic. Patients' conditions worsen for myriad reasons, usually at no fault of the care provider. IT should then provide a rapid response to the situation, immediately notifying physicians of the problem and alerting other personnel who can provide aid.
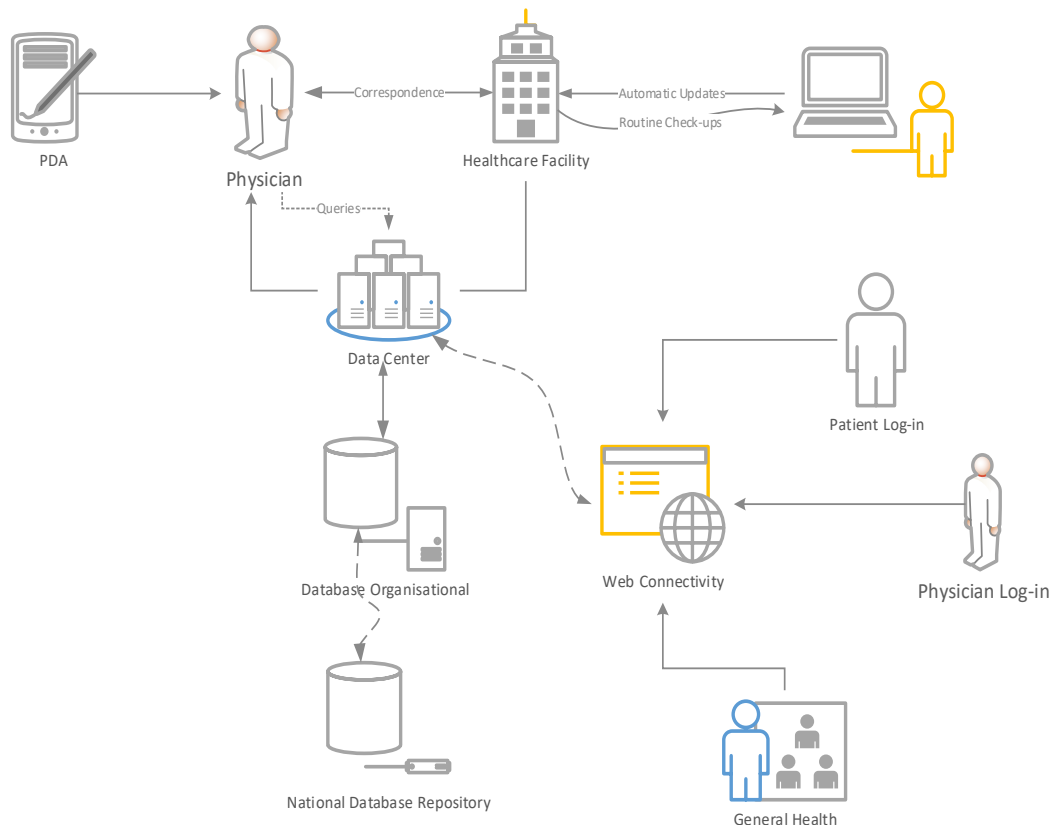
Figure 7. E-Healthcare Innovation Model

The advent of Personal Digital Assistants (PDAs) coupled with cellular technology enable effective data interchange without tying providers down to traditional means of communication. As shown in Figure 7, by automatically relaying patient data to a physician's PDA, the information system could provide a critical link in the healthcare chain. Furthermore, IT could monitor the situation, tracking the performance of individual patients and ensuring a watchful recovery from an adverse event. Information systems have the capability to increase the mobility and interconnectivity of healthcare providers, which will then improve the safety and quality of care for patients. By embracing the electronic way through reliance on continuously evolving technologies, healthcare providers can bridge the proximity gap between patients and clinicians. Traditional treatment methodologies require physicians and patients to be at the same location, or for the absentee physician to be near a telephone to answer questions and relay diagnoses. Healthcare providers are already familiar with the process of relaying information using pagers and mobile telephones, so the additional capabilities of PDAs and Wi-Fi technology will be an incremental improvement rather than a revolutionary change.

4. Conclusion

The world, of which we are a part, thrives on information. IT has revolutionized today's business world, enabling survival in the turbulent ebb and flow of commerce. An organization no longer has the luxury of choosing whether or not to implement IT. Information systems now provide the technological backbone of the business world. The healthcare industry must continually embrace the benefits provided by IT in order to survive in a demanding and changing environment. Changing perspectives to categories IT as strategic weapons for improving safety and treatment rather than merely task organizers to facilitate easier accounting and managerial decisions is necessary in order to

ensure the acceptance of IT throughout the healthcare culture. The trend toward a national healthcare database is rapidly emerging. While privacy considerations remain a key roadblock in the path of this initiative, new technologies will enable the necessary levels of security required to facilitate such a system. Proposed outlines for organizational IT system architecture continue to emerge. By working to accommodate these changes, and to fully integrate IT into the daily processes, healthcare organizations can remain frontrunners in their fields. Furthermore, taking the necessary incremental steps toward internal IT improvement will prevent the healthcare providers from taking a catastrophic leap in the future to try to catch up with others in the industry. Employing emerging technologies successfully will help firms distance themselves from the competition and monetize the benefits of these technologies. IT provides an avenue to enable the healthcare industry to flourish. Embracing this technology and its benefits creates an environment that is conducive to patients and care providers alike. Information systems work to create fluidity in the healthcare process. IS provides patients with better, safer, faster, and more accurate treatments, and it allows the organization to monitor patients, inventories, billing processes, and trends in healthcare. The vision that information will be available online at any place, at any time, in multi-media form if relevant, by those who need it, serves healthcare professionals, patients, the public and hospitals. Ultimately, the framework will improve competitive advantage and deliver value to healthcare industry.

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