Innovation in Healthcare Delivery Systems:

A Conceptual Framework

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ABSTRACT

The healthcare industry has experienced a proliferation of innovations aimed at enhancing life expectancy, quality of life, diagnostic and treatment options, as well as the efficiency and cost effectiveness of the healthcare system. Information technology has played a vital role in the innovation of healthcare systems. Despite the surge in innovation, theoretical research on the art and science of healthcare innovation has been limited. One of the driving forces in research is a conceptual framework that provides researchers with the foundation upon which their studies are built. This paper begins with a definition of 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 healthcare. Based on the proposed definition of healthcare innovation, the dimensions of healthcare innovation, the process of healthcare innovation and the conceptual framework, this paper opens the door for researchers to address several questions regarding innovation in healthcare. If the concept of healthcare innovation can be clarified, then it may become easier for health policymakers and practitioners to evaluate, adopt and procure services in ways that realistically recognize, encourage and give priority to truly valuable healthcare innovations. Lastly, this paper presents 10 research questions that are pertinent to the field of healthcare innovation. It is believed that the answers to these and other such questions will hold the key to future advances in healthcare innovation research.

Key words: Healthcare innovation, innovation process

Introduction

Innovation in healthcare continues to be a driving force in the quest to balance cost containment and health care quality. Innovation is considered to be a critical component of business productivity and competitive survival [Zaltman, et al., 1973]. Technological innovations present vast opportunities for 1) product innovation – the introduction of new types of goods and services for the external market and 2) process innovation – enhancement of internal production processes for goods and services [Perri 6, 1993]. Product innovations are essential to the life of any organization since they provide the most obvious means for generating incremental revenues [Johne, 1999]. Similarly, process innovation is concerned with improving internal capabilities [Johne and Davies, 2000; Johne, 1999] and safeguarding and improving quality [Johne, 1999].

In 2005, industryweek.com did a study about the effects of innovation on a company and they found that, "overall revenue growth (78%), customer satisfaction (76%), growth in revenue from new products or services (74%), increased productivity (71%), and earnings/profit margins (68%)" were a result of the impact of innovation efforts. [Jusko, 2008].

Medical science has advanced exponentially during the last half a century. Yet, the paper system has stymied the ability of care givers to access the information vital to the delivery of care. Patient information is routinely held in static paper storage systems and managed with a silo mentality. Of the $600 billion spent on lab tests each year in the U.S., 70 percent of that money pays for paperwork, says Shanker S. Sastry, Engineering Dean at the University of California, Berkeley, and Director Emeritus of the Center for Information Technology Research in the Interest of Society (CITRIS). Paperwork is prone to costly errors. Sastry argues that huge savings can be realized by more and better use of electronic recordkeeping, employing software that can detect mistakes and issue prompts [Grose, 2008]. When healthcare providers have to rely on paper records, the sharing of information and the delivery of care become challenging and often impossible. Without full and secure access to patient records, healthcare services providers would give up the vital insight provided by the patients' health history. The healthcare industry sits on the hinge of a future in which physicians can instantly share imaging and test results with colleagues in the same building or across the country or continent. Patients should be able to have immediate access to their own records and be able to transmit or carry it from one healthcare provider to another. Innovation has become a critical capability of all healthcare organizations [Lansisalmi, et al., 2006]. In addition, new digital information, nanotechnology, semiconductor products, and genetic engineering are revolutionizing health care, making old assumptions invalid and creating unanticipated prospects for innovation and improvement of existing processes [Govindarajan, 2007]. The last century has produced a proliferation of innovations in the health care industry aimed at enhancing life expectancy, quality of life, disgnostic and treatment options, as well as the efficiency and cost effectiveness of the healthcare system [Varkey, Horne and Bennet, 2006]. These include, but are not limited to, innovations in the process of care delivery [Varkey and Athyal, 2005], medications, and surgical interventions [Varkey, Horne and Bennet, 2006]. In a study by Fuchs and Sox (Fuchs and Sox, 2001), medications (e.g., angiotensin-converting enzyme inhibitors, statins, proton pump inhibitors, antidepressants), diagnostic modalities (e.g., magnetic resonance imaging, computerized tomography scanning, mammography), and procedures (e.g., balloon angioplasty, coronary artery bypass graft, cataract extraction) made the list of top 10 medical innovations.

Definitions of Innovation

Innovation can be defined as "the intentional introduction and application within a role, group, or organization, of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, or wider society" [West, 1990]. This definition is largely accepted among researchers in the field [Anderson, et al., 2004], as it

captures the three most important characteristics of innovation: (a) novelty, (b) an application component and (c) an intended benefit [Lansisalmi, et al., 2006]. In line with this definition, innovation in healthcare organizations are typically new services, new ways of working and/or new technologies [Lansisalmi, et al., 2006]. From the patient's point of view, the intended benefits are either improved health or reduced suffering due to illness [Faulkner and Kent, 2001].The Advisory Committee on Measuring Innovation in the 21st Century Economy (2007) defines innovation as "the design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm." [Varkey, et al., 2008] define innovation as the successful implementation of a novel idea in a way that creates compelling value for some or all of the stakeholders. Innovation can be categorized by its impact on stakeholders as nondisruptive or disruptive. Nondisruptive innovations [Moore, 2004], also referred to as incremental [Hamel, 2000; Harvard Business Essentials, 2003], evolutionary, [Govindarajan, 2007], linear, [Hamel, 2000], or sustaining, [VHA Health Foundation, 2006], improve on something that already exists but in a way that allows expanded opportunities to be met, or existing problems to be solved, [Harvard Business Essentials, 2003]. Christenson, et al., (2004) propose a narrower focus of impacting a company: "anything that creates new resources, processes, or values or improves a company's existing resources, processes, or values." What is important in defining innovation is the recognition that something new and hopefully better will emerge.

Disruptive innovations, also called radical, [Harvard Business Essentials, 2003; Hage and Hollingsworth, 2000], revolutionary, [Govindarajan, 2006; Harvard Business Essentials, 2003], transformational, or nonlinear, [Hamel, 2000], refer to innovations that disorder old systems, create new players and new markets while marginalizing old ones, and deliver dramatic value to stakeholders who successfully implement and adapt to the innovation. The Minute Clinic, with limited service diagnostic and treatment offerings in major retail outlets, is an example of a nondisruptive structural innovation, [Varkey, 2008]. The clinics are easily accessible, efficient, and cost-effective and have generated significant interest in consumer markets across the United States. However, they have not replaced existing medical facilities.

West and Farr [1990] define organizational innovation as the intentional introduction and application (within a group or organization) of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, organization or wider society. There have been several attempts to classify innovation into categories.

Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations [UNESCO Institute for Statistics, 2005]. UNESCO makes the distinction among the four types of innovation as follows:

Product innovation: introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.

Process innovation: implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. The customer does not usually pay directly for process, but the process is required to deliver a product or service and to manage the relationship with the various stakeholders.

Marketing innovation: implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

Organizational innovation: implementation of a new organizational method in the firm's business practices, workplace organization or external relations.

Innovations in health care are related to *product*, *process*, or *structure* [Varkey, et al., 2008]. The product is what the customer pays for and typically consists of goods or services (for example, clinical procedure innovations). Process innovation entails innovations in the production or delivery method. According to Varkey, et al., the customer does not usually pay directly for process, but process is required in order to deliver a product or service. A process innovation, therefore, would be a novel change to the act of producing or delivering the product that allows for a significant increase in the value delivered to one or more stakeholders. Structural innovation usually affects the internal and external infrastructure, and creates new business models.

Healthcare innovation can be defined as the introduction of a new concept, idea, service, process, or product aimed at improving treatment, diagnosis, education, outreach, prevention and research, and with the long term goals of improving quality, safety, outcomes, efficiency and costs.

Information technology remains a key driver of innovation in healthcare. According to Gupta (2008),

"while hospitals and other care providers have long been quick to adopt breakthrough technology in medical devices, procedures and treatments, far less attention has focused on innovations in networking and communications. This is partly because of concerns about breaches in security and patient privacy, and because healthcare until recently was a service always performed locally and in person."

With the dramatic improvements in network security and the ability to transmit images and data globally, the opportunity to revolutionize the healthcare industry has never been greater. There

are four major ways in which Information Technology (IT) will revolutionize health care, [Gupta, 2008]:

More offshore services: There is a tremendous growth in the outsourcing of diagnostic services – particularly imaging, such as X-rays and mammograms and consultations by specialists. Telemedicine has been used by doctors in the U.S. and other countries to provide care to patients in hard-to-reach and underserved locations. Gupta notes that the future of telemedicine lies in its use as a way of distributing work loads and lowering costs. An example is Teleradiology, a process in which X-rays are taken at one location and then transmitted to doctors at another site. The factors driving the growth in teleradiology include a significant shortage of radiologists, aging populations and more of imaging in trauma situations, which in turn has fueled the need for round-the-clock radiological services in emergency departments [Gupta, 2008].

Integration of health information systems: Much of today's health information systems were designed to function as silos, with their own rules and formats. They often inhibit the opportunity for information to be globally integrated and readily available. In some cases, a patient's chart in one hospital cannot be read by another hospital. According to Gupta, not only are different languages and measures sometimes used, but conflicts between encryption and other software can make it impossible for systems to exchange data electronically. The goal should be to create medical records that can travel with the patient.

Drug safety monitoring on a global scale: The need for an international database on drug safety has steady increased, especially as more people travel across the globe. There are programs aimed at addressing the gaps that currently exist, however, more work is required. Medwatch, (an initiative of the U.S. Food and Drug Administration) investigates and reports on adverse drug reactions and other safety issues involving medical products. Gupta, 2008 notes that no agency routinely collects and shares information between countries.

More high quality information to doctors and patients: Websites such as WebMD have become a source of information for patients and doctors. These sites receive contributions of medical materials from doctors and scientists, and are enhanced by the automated search tools. Many such sites draw materials from on-line text books and medical journals.

Healthcare Innovation and the Challenges of Labor

The universal shortage of nurses and other key practitioners further advances the argument in favor more innovation in healthcare. This situation has been exacerbated by the projected increase in the retirement of current staff in the next 10 years [Pirkanmaa Hospital District, 2004; Warne & McAndrew, 2002].

Tracking Technologies

Automatic-tracking software programs were introduced more than a decade ago to help hospitals prevent infant abductions. Now, institutions are putting electronic tags on all sorts of things, from EKG monitors and ventilators so they can be readily be located in an emergency, to surgical sponges so they do not get sewn up inside a patient. According to Landro, 2008, some hospitals have begun tagging arriving patients to help cut waiting times in emergency rooms. The growing use of tracking technology has privacy experts warning that hospitals mast take steps to protect any personal data from being inadvertently released. About 10% of U.S. hospitals use some kind of radio frequency identification, or RFID, tags, the most common tracking technology, according to ECRI Institute, a nonprofit consulting group. Active RFID tags were the subject of a study by the Journal of the American Medical Association, JAMA, that warned of possible interference with medical devices.

Other Examples of Healthcare Innovation

1. An electronic Personal Health Record solution (ePHR) to enable consumers to record and selectively share healthcare information about themselves and their loved ones in a secure manner.

2. An electronic Clinician Health Record solution (eCHR) to enable physicians and other healthcare providers to securely access healthcare information collated from any number of trusted sources relating to an individual patient in a structured and easily accessible way.

3. A healthcare informatics platform to enable all healthcare data to be stored and accessed via the ePHR and eCHR solutions. The platform is based on industry-standard technologies and data models.

4. The use of robots in rehabilitation therapy for victims of stroke. Robots being built by a team at MIT are able to help deliver therapy with the promise of reducing elbow and shoulder impairments in stroke victims [Riezenman, 2008].

5. High definition television signals used in cameras (known as videoscopes) by surgeons to snake through patients' bodies to search for stomach tumors, perform colonoscopies, or assist in removing diseased gallbladders.

6. The da Vinci Surgical System allows physicians to perform minimally invasive procedures most commonly in the treatment of urological and gynecological conditions. Seated at a console, a physician can view the surgical area through a tiny camera that reveals magnified 3-D images. The controls at the console allow the physician to move robotic "hands" with precision, eliminating the natural tremor of human hands. The physician can perform complex surgery using 1- to 2-centimeter incisions, and patients generally recover in less than 48 hours.

7. The CyberKnife Stereotactic Radiosurgery System is used by physicians to deliver high doses of radiation with great accuracy, which allows incisionless surgery for previously inoperable tumors. It minimizes radiation exposure to healthy tissue and lets physicians operate on multiple tumors in several locations. Patients spend between 30 minutes and an hour and a half on the operating table (some cases may require up to five sessions), and there is no recovery time.

8. The Elekta Synergy Cone Beam CT system for image guided radiation therapy provides a 3-D view of the patient and can detect very small shifts in position that can be corrected before treatment. The system incorporates a linear digital accelerator with a built-in CT scanner that, like the CyberKnife, allows physicians to deliver a high dose of radiation with great accuracy. In the past, it was difficult to target the tumor because it could not be seen. It is primarily used to treat prostate cancer and cancers of the head and neck.

9. Ablation therapy has transformed what 20 years ago was a risky, invasive open-heart surgery for treatment of abnormal heart rhythms to a procedure that takes a matter of hours and has a 95 percent success rate. The therapy can fix an irregular heartbeat permanently, possibly replacing defibrillators and pacemakers. Small wires can be routed through the femoral vein and placed into the heart so the electrical conduction system of the heart can be evaluated and the exact location of the problem can be identified using 3-D mapping. Then radiofrequency energy is transmitted to the problem area and destroys selected heart muscle cells in a very small area to stop the area from conducting the extra impulses that caused rapid heartbeats.

10. Intel Corp. is taking its next step in building a business in health care by introducing technology to help homebound patients with chronic medical problems such as diabetes, hypertension and heart disease [Clark, 2008]. Intel's offerings include a simplified computer and software that are designed to help elderly people and other patients monitor and manage their conditions at home. It connects to medical devices such as scales, blood-pressure monitors and glucose readers, recording information that can be shared with health professionals over the Internet.

Health care is rich in evidence-based innovations, yet even when such innovations are implemented successfully in one location, they often disseminate slowly—if at all. Diffusion of innovations is a major challenge in all industries including health care [Berwick, 2003]. The International Council of Nurses (ICN) has developed a website designed to showcase innovations in nursing. The ICN Innovations Database is a web based resource designed to facilitate the dissemination of nursing innovations globally.

Key Stakeholders of the Healthcare Innovation Process

The process of innovation is both complex and multi-dimensional regardless of the industry in which it is being applied. Innovation in the healthcare industry has its own unique challenges. Any attempt to understand the process of innovation in healthcare must begin with an in-depth analysis of its challenges. There are five key stakeholders in the innovation process, and each has its unique and deliberate needs, wants and expectations as follows:

Stake Holders	Needs, Wants & Expectations
Physicians and Other Care Givers	Improved clinical outcomes, improved diagnosis and treatment
Patients	Improved patients' experience, improved physiological well-being, reduced waiting time, reduced delay
Organizations	Enhanced efficiency of internal operations, cost containment, increased productivity and quality and outcomes improvement
Innovator Companies	Profitability, improved outcomes
Regulatory Agencies	Reduced risks and improved patient safety

Several researchers have suggested that it is difficult to change the behavior of clinicians [Greco and Eisenberg, 1993], current medical practices, and healthcare organizations [Shortell, Bennett, and Byck, 1998; Shortell et al., 2001]. The adoption of healthcare innovations is often regulated by laws, making changes more laborious [Faulkner and Kent, 2001]. In healthcare, typical starting points of an innovation process may lead to death, disability, or permanent discomfort [Lansisalmi, et al., 2006]. This, together with the clinicians' tendencies to protect their individual autonomy and reputation, can promote a culture of blame and secrecy that inhibits organizational learning and the generation of innovations [Huntington, Gilliam and Rosen, 2000]. Furthermore, new practices in patient care are traditionally scrutinized thoroughly in their early development phase so that potentially harmful innovations are not adopted [Faulkner and Kent, 2001]. Any attempt at modeling the process of health care innovation must take into account all of the five key stakeholders.
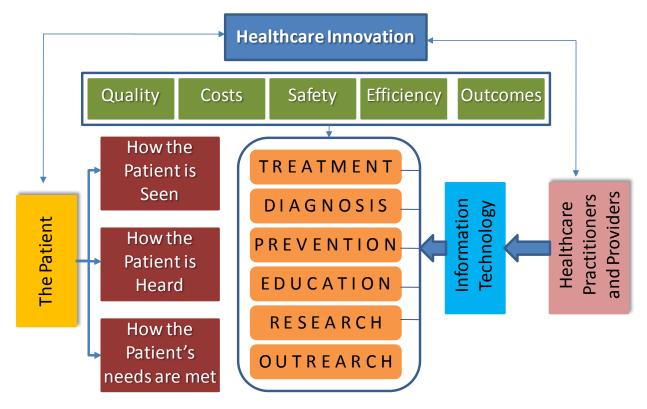
Figure 1: A Conceptual Framework for Innovation in Healthcare

As Figure 1 shows, healthcare organizations serve six distinct purposes – treatment, diagnosis, prevention, education, research and outreach. In serving these purposes, healthcare organizations must effectively manage quality, costs, safety, efficiency and outcomes. At the very core of healthcare innovation are the needs of patients and the healthcare practitioners and providers who deliver care. Quite often, healthcare organizations arrive at innovation by relying on new or existing information technology. When successful, healthcare innovation focuses on three areas the most – a) how the patient is seen, b) how the patient is heard, and c) how the patient's needs are met.

Role of Research and Development

In industry, there are two closely related processes by which new products/services and new forms of old products/services are created through technological innovation - two types of research, basic and applied. Basic research is directed toward a generalized goal (e.g., genetic research in a pharmaceutical laboratory). Applied research directs the results of basic research toward the needs of a specific industry and results in the development of new or modified products or processes. In addition to carrying out basic and applied research and developing models, R&D staff may evaluate the efficiency and cost of the product [Britannica Concise Encyclopedia, 2006].

There is a fundamental distinction between R&D in the physical, engineering, and life sciences and R&D in the social sciences and humanities. Important areas of research and development in the physical, engineering, and life sciences fields include biotechnology, nanotechnology, pharmaceutical, chemical and materials science, electronics, aerospace, and automotive. Important fields of research and development in the social sciences and humanities include economics, sociology, anthropology, and psychology [Bureau of Labor and Statistics, 2008]. These distinctions are critical to the process of innovation in healthcare [Omachonu and Einspruch, 2009]. Many of the innovations in healthcare rely on the cognitive sciences due to the special considerations that must be made to accommodate the patients' experience. Clinicians are, by virtue of their training, familiar with experimental research methods driven by the fields of basic and life sciences. When certain healthcare innovations seek to create a new structure or organizational practice, they force the clinician to venture outside the familiar into the cognitive sciences. Sometimes, the cognitive sciences fail to produce the types of quantitative answers to research questions that clinicians want and expect. This creates credibility problems in the eyes of many medical practitioners [Pope, 1995; Pope and Mays, 2000].

Cognitive Science

Cognitive science may be broadly defined as the multidisciplinary study of mind and behavior [Lugar, 1994]. It draws on multiple empirical disciplines, including psychology, psychiatry, philosophy, neuroscience, linguistics, anthropology, computer science, sociology and biology. Perception is the ability to take in information via the senses and process it in some way. Vision and hearing are two dominant senses that allow us to perceive the environment.

The Process of Innovation

Despite the fact that much has been written about the process of innovation; however, there is very little information concerning the process of innovation in health care. Although the process of innovation typically is not linear, the majority of innovations go through the process of problem identification and idea generation, idea evaluation, development, first use, commercialization, and diffusion [Varkey et al., 2008].

The Process of Healthcare Innovation

In order to fully understand the process of innovation in healthcare, it is critical to answer the question, what is the catalyst for healthcare innovation? Another way to ask the question is to ask a) if innovation chases needs or b) if needs chase innovation? In the first case, new or existing technology searches for a problem to solve, whereas in the second case, new or existing problems chase after solutions in the form of innovation. Stated differently, it comes down to solutions looking for problems to solve versus problems looking for solutions to adopt. In either case, technology plays a pivotal role in facilitating the process. Figure 1 below is an example of how the process works.
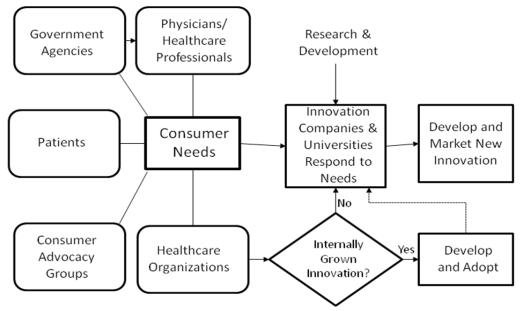
Figure 2: The Process of Healthcare Innovation

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. 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. 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.

Omachonu and Einspruch (2009) presented a Service Organizations Innovation Process model (Figure 3) as shown below. The implications for healthcare organizations are quite significant.

There are at least three stages to the maturing of a services industry. First, it creates a service that the market needs. Then it improves the service to meet what the market wants and demands. [Beckwith (1997)]. According to Beckwith, this is usually the stage where most services companies assume they have reached the goal. But some rare companies move beyond stage two, they innovate and devise services that would never even occur to a customer to ask for. They create "the possible service." This kind of service can not be created by asking the question "what do my customers want?" but rather "what would they love?" This underscores the idea that services innovation is not always driven by customer input. In order to obtain answers to the question "what would they love?", healthcare organizations can examine the interactions between services and technology. The answers tend to lie in one of the four quadrants depicted in Figure 3 below. Stage III innovation can be supported by applying a new technology to new service (quadrant 1), new technology to an existing service (quadrant 2), existing technology to existing service (quadrant 3), and existing technology to a new service (quadrant 4).
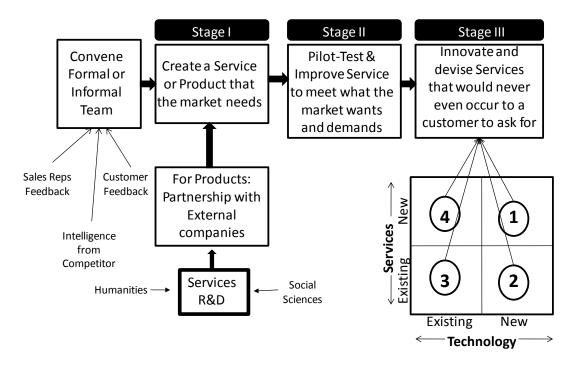

Figure 3: Service Organizations Innovation Model

The Dimensions of Innovation in Healthcare

There are two principal dimensions of healthcare innovation – environmental and operational dimensions. These dimensions motivate or affect the introduction of innovation in healthcare organizations. The operational dimension includes the improvement of clinical outcomes, efficiency, effectiveness, aging population, nursing shortage, patient satisfaction, profitability, patient safety, improved quality and cost containment. The environmental dimension includes physician acceptance, organizational culture, regulatory acceptance, and partnerships and collaborations. Figure 4 below shows the factors.
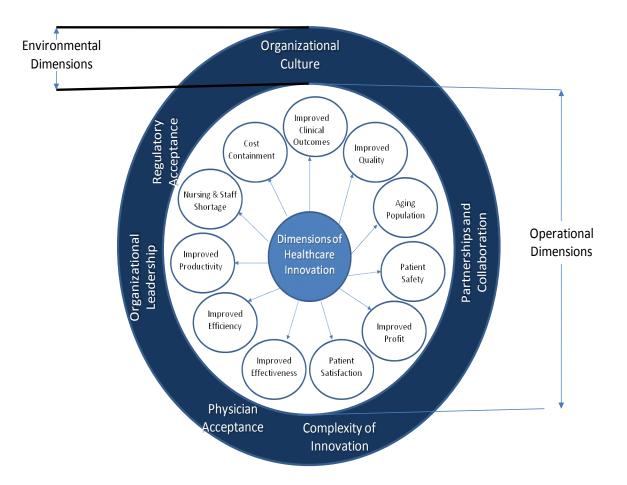

Figure 4: Environmental and Operational Dimensions of Healthcare Innovation

The dimensions of healthcare innovation can be divided into two bands – the outer band which represents the environmental dimensions and the inner band which represents the operational dimensions. The Environmental Dimensions (ED) include organizational leadership, organizational culture, regulatory acceptance, physician acceptance, complexity of innovation, and partnerships and collaboration. Similarly, the Operational Dimensions (OD) of healthcare

innovation include patient satisfaction, profitability, effectiveness, efficiency, patient safety, aging population, productivity, cost containment, labor shortage, clinical outcomes, and quality.

As organizations strive for ways to control health care spending, ameliorate labor shortages, address the growing needs of an aging population, and respond to a more informed, sophisticated, and demanding consumer base [Elaine, 2002], the need for innovation has become critical to enhance quality of care [Varkey, Horne and Bennet, 2006].

Diffusion of Health Care Innovation

There are seven critical success factors for the dissemination of health care innovation, Berwick (2003).

- Formal mechanisms to find sound innovations that should be disseminated
- Find and support innovators
- Invest in early adopters
- Make early adopter activity observable
- Trust and enable reinvention
- Create slack (including resources) for change
- Lead by example

The best of innovations may not be successful if the market or environment is not ready for adoption [Varkey, et al., 2008]. Berwick notes that in health care, invention is hard, but dissemination is even harder.

Questions for further research and discussions

There are several questions that must be addressed in trying to measure, manage, and deploy healthcare innovation. They include the following:

I.   How would innovation affect the key stakeholders of a healthcare organization?

II.   What are the implications of a particular healthcare innovation on treatment, diagnosis, prevention, education, research and outreach?

III. Since every organization is different in terms of its culture, leadership, people, and resources, what steps are taken by individual healthcare organizations in adapting an existing technology for their purposes?

IV.   What are the principal catalysts for healthcare innovations – the patients, physicians, costs, safety, quality, profitability, productivity, etc.?

V.   How do physicians, nurses and other clinical professionals learn about the latest innovations in their fields? Is it done through conferences, medical journals, from colleagues, other professions, etc? What are the barriers to disseminating healthcare innovation? What is the average time it takes for disseminating innovation? What is the cost of delays in disseminating healthcare innovation?

VI.   To what degree do regulatory compliance issues drive the necessity for healthcare innovation?

VII.   How much does healthcare innovation depend on information technology? In which of the following sectors (treatment, diagnosis, research, outreach, education, and prevention) is the application of information technology more prevalent, and why?

VIII.   Consider the four quadrants presented as part of Figure 3. What is the nature of the interaction between new and existing technology and new and existing services? Are there differences that are driven by the type of healthcare facility or organization?

IX.   With regards to innovations in healthcare, how much "cross pollination" occurs within the various professions represented in healthcare? For example, do nurses come up with innovative ideas that mainly support nursing practice, or do nurses get help from other disciplines?

X.   How should the healthcare industry address the issues of maintainability, sustainability and usability with regards to healthcare innovation?

According to Lehoux, et. al. (2008) innovation designers rarely tap into the knowledge generated by health services researchers while health services researchers often fail to provide key insights about the *comparative value* of emerging innovations, such as their significance within the broader universe of desirable health care interventions. As a result, after decades of research, there is an acute lack of knowledge about ways to promote the design of *more valuable* innovations [Lehoux, 2006]. Part of the solution is to develop a new collaborative policy-oriented research agenda that can bridge design processes, and health care needs and priorities. This idea is beginning to be recognized by academics and high-level policy-makers around the world [Reiss, 2003; HM Treasury, 2004].

Many of the issues discussed in this paper can become the basis for empirical research inquiries. Healthcare innovation can become a formal discipline that appeals to a multidisciplinary research audience. The conceptual framework presented in this paper should open a dialogue regarding the interaction among the many factors driving innovation in healthcare. The dimensions of innovation identify the environmental and operational factors that influence healthcare innovation. The innovation process presented in this paper depicts both the thought and practical steps followed by many healthcare organizations in pursuing the benefits of innovation. The information presented in this paper may assist policy makers in understanding the many components of healthcare innovation, thereby influencing the quality of decision-making.

About the Authors

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Norman G. Einspruch received the Ph. D. degree in Applied Mathematics from Brown University. He was employed by Texas Instruments Incorporated for eighteen years in a variety of technical/managerial positions, including Director of the Central Research Laboratories. During the last thirty-two years at the University of Miami, he has served as Dean of the College of Engineering and as Chairman of the Department of Industrial Engineering; he is Senior Fellow in Science and Technology, Professor of Electrical and Computer Engineering and Professor of Industrial Engineering. His current research area, in which he has published extensively, relates to characterizing the similarities and differences between the Goods Sector and the Services Sector of the economy, with special emphasis on the role of technology and technology management. He is a Life Fellow of the Institute of Electrical and Electronics Engineers, a Fellow of the American Physical Society, a Fellow of the Acoustical Society of America, and a Fellow of the American Association for the Advancement of Science. neinspruch@miami.edu P.O. Box 248581, Coral Gables, FL 33124-8581, (305) 284-3812.

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