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Managing Technological Innovation

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Exploring Healthcare Information Technology Adoption and Resistance through the Lens of Technological Innovation

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A Brief History of Technological Innovation in Healthcare

Health care, or more specifically the practice of medicine, is regarded today as a formal scientific discipline. Terms like "evidence-based medicine" mesh with the astonishing variety of technology used to treat human illness, reinforcing a popular image of "traditional" medicine - complete with white coats, esoteric procedures, miracle drugs, and high-tech devices.

As a science, medicine (to paraphrase Kuhn) can also subject to practitioner biases, the establishment of socially constructed institutions and social factors, and above all, the impact of changing paradigms on theory and practice. Examples of medical paradigms come easily to mind: the association of physical pathology with illness; the development of the germ theory and antisepsis; and the potential for genetics and molecular biology to "personalize" prevention and treatment of disease.

In all of these cases, a sequence of successful and failed innovations drove all aspects of how we practice medicine today.

The goal of this paper is to take explore the diffusion of, and resistance to, Healthcare Information Technology (HIT) viewed in the context of innovation theory. It is hoped that this brief treatment might serve as a solid foundation for my further studies of innovation in medical informatics.

Innovation:

In Everett Rogers' classic work, Diffusion of Innovations (Rogers, 2003), he defines an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption." The U.S. government Agency for Healthcare Research and Quality (AHRQ) expands this definition to include "a product, a service, a process, a system, an organizational structure, or a business model."

Such a wide scope of use makes it nearly impossible to generalize about "healthcare innovation" as a single concept. For example, the online index to the journal Health Affairs finds over 1,500 full text articles on the keyword "innovation". Narrowing our discussion to “technological innovation helps”, but this sub-category alone would include medical techniques and procedures, drugs, advances in medical genetics, and medical devices.

While there may well be universal themes of innovation that cross all of these areas, my interest leads me to focus on healthcare information technology, or HIT.

Types of Health IT

To discuss innovation with respect to HIT, we must further define it. Broadly speaking, HIT is itself a very large grouping of computer systems and software that include uses for, in addition to direct patient care, exchanging electronic data; managing population and public health; administration, finance, and logistics management systems; databases and applications for quality management, academic research and commercial purposes; and even software embedded in smart medical devices. Even within this relatively narrow pond, a wide net would still be needed.

I have chosen to focus on HIT used in direct patient care, or clinical HIT. Clinical HIT can also be broken down, and for the purposes of discussion the following categories will be used. As with any jargon, the terms below are still evolving and may be used quite differently in other contexts or by other authors.

Electronic Health Record (EHR)

> An EHR is a computerized database for individual medical records. An older, and roughly synonymous, term is Electronic Medical Record (EMR). There hundreds of commercial vendors for EHRs and several open source alternatives including the Veteran Administration's highly regarded VistA EHR and an international effort OpenEMR.

The EHR market can be roughly divided between vendors providing systems to large health systems and hospitals and those that cater to physician practices and clinics. I will distinguish these, despite the significant oversimplification, as inpatient (hospitals) vs. ambulatory (doctors, clinics, and nursing homes).

Computerized Provider Order Entry (CPOE)

CPOE is a function of an EHR that allows physicians and other care providers to electronically order medications, diagnostic tests, and procedures. CPOE is the ideal place to target Clinical Decision Support (CDS) computerized alerts and reminders because of the immediate impact on decision making.

Personal Health Record (PHR)

PHRs are computerized medical records managed explicitly by the patient or consumer. Examples include Google Health and MicroSoft's HealthVault. Ideally, PHRs will be able exchange selected information with EHRs, but under conditions the chosen by the consumer.

Clinical Decision Support System (CDSS)

CDS is actually a function of electronic records that may be built into an EHR, or added as a "module". The goal of clinical decision support is to provide real-time guidance to users in the form of alerts, reminders, recommendations, access to context-sensitive reference materials, or any other function to support the user in providing care.

Common CDS examples include warning messages for inappropriate medication orders or dangerous drug interactions; online diagnostic references in the form of "infobuttons"; and other types of workflow aids that go beyond the basic data management functions of the EHR.

One might suppose that automatic diagnosis would be a component of CDS. While it was a focus of early informatics research, computerized diagnosis and treatment

recommendations ("algorithmic medicine") failed to match early expectations and is largely absent from contemporary clinical systems.

Clinical Information System (CIS)

CIS is often used as a synonym for any computerized clinical system. Here I use it to distinguish clinical systems used for departmental processing (laboratory, diagnostic imaging, dietary services, etc.) from an EHR. In many cases, these "ancillary systems" are actually part of the EHR or connected through electronic interfaces.

Health Information Exchange (HIE)

The types of HIT described thus far are typically selected, implemented, used, and managed by individual institutions ranging from small physician practices or clinics to large regional or national delivery systems (Kaiser Permanente, Veteran's Administration).

An HIE provides the infrastructure, standards, and possibly even operational resources to securely link HIT systems used by various stakeholders within a region. While early attempts (known as Regional Health Information Organizations, or RHIOs) had mixed success, electronically sharing health information is seen as a critical piece of current healthcare reform initiatives. The U.S. has recently allocated billions of dollars in part to help create regional HIEs, and connect them in a National Health Information Network.

HIT: Beyond the Hype

HIT is not new. Hospitals, clinics, and physicians adopted computers and software for record keeping and administrative functions with much the same rate as other industries. Indeed, many of the major players in the EHR market (both in the inpatient and ambulatory spaces) come from an HIS (Hospital Information System) or PMS (Practice Management System) lineage.

What has changed is that HIT has been transformed from a supportive technology (scheduling, patient registration, billing, and administration) to a powerful enabler of change: change that includes improved patient safety, heightened efficiency, and measurable quality; change that might also help "bend the curve" on the unsustainable rise in the costs (in dollars, resources, and lives) of disease prevention, diagnosis, and treatment.

I believe a great deal of this shift in mindset can be traced to the Institute of Medicine (IOM) report To Err is Human: Building a Safer Health System (IOM, 2000) and its companion report Crossing the Quality Chasm (IOM, 2001). While it has become a cliche to quote the report's estimate of 44,000 - 98,000 annual U.S. deaths from medical error and a total cost of $17 billion, the IOM's impact on policy and perception has been unmistakable.

From the start, HIT has had a key role in addressing these issues. The ninth recommendation (of thirteen) from Crossing the Quality Chasm reads as follows:

> *"Recommendation 9: Congress, the executive branch, leaders of health care organizations, public and private purchasers and health informatics associations and vendors should make a renewed national commitment to building an information infrastructure to support health care delivery, consumer health, quality measurement and improvement, public accountability, clinical and health services research and clinical education. This commitment should lead to the elimination of most handwritten clinical data by the end of the decade."*

The passage of the American Recovery and Reinvestment Act (ARRA) in February, 2009, puts unprecedented Federal financial resources behind making such recommendations official policy. Within the ARRA legislation is over $19 billion to help the government promote adoption of HIT, create a national HIT infrastructure (along with much needed technical standards), and provide financial incentives through Medicare and Medicaid to providers who adopt EHRs (followed later by penalties for those that don't).

Known as HITECH (for Health Information Technology for Economic and Clinical Health Act), Title XIII of ARRA has brought about what has been described as a feeding-frenzy of vendors, providers, and consultants seeking a piece of the action. EHR vendors have been positioning their products and announcing programs (one revealed an EHR "cash for clunkers" program) to help meet yet-to-be defined HITECH "meaningful use" requirements; providers are actively seeking ways to maximize the incentive payments for buying an EHR; and consultants are everywhere to act as guide-dogs.

Even here, innovation research can be seen to play a role. A key strategy to foster diffusion of EHRs is the HITECH creation of Regional Extension Offices modeled after the agricultural networks created to diffuse best-practices in farming. Parallels are striking between the adoption behavior of farmers choosing seed-stock and clinicians choosing to use or reject HIT.

Lost, perhaps, in the white-hot spotlight on HIT is the evidence that EHR, CDS, and HIE can, and do, provide real benefits. But, like any innovation, unintended consequences can also result.

The Benefits and Risks of HIT:

Informatics researcher Charles Friedman developed a very simple diagram that describes the "Fundamental Theorem" of biomedical informatics: clinicians should do better with HIT than without.

FIGURE 1.6. A "Fundamental Theorem" of biomedical informatics.

Figure from:
Friedman C, Wyatt J. Evaluation Methods in Biomedical Informatics. New York: Springer, 2006

The literature supports this theorem well, and provides good evidence that:

1) EHRs
- Can facilitate secure access to clinical data within and across institutions.
- Allow for better coordination of patient care.
- Support improved collection and authorized use of electronic clinical data.
- Improve the quality of care by eliminating handwriting and paper records.
- Facilitate quality measurement and create new research opportunities.

2) CDS (when paired with CPOE) can provide effective interventions in the form of alerts, reminders, and online reference content that improves the safety of medication and helps avoid other types of medical error.

However, several investigators have also begun to look into what Rogers calls "undesirable, indirect, or unanticipated consequences" in the use of EHR/CDS. Much of this work has been done by Joan Ash and her colleagues on the Provider Order Entry Team (POET) at Oregon Health and Science University who coined the term "e-Iatrogenesis" for harm caused or facilitated by the use of HIT.

An early (and controversial) study by Han, et al, found a significant correlation between the implementation of an EHR in a pediatric hospital and an increase in patient mortality. While a subsequent rebuttal pointed out that other process changes unrelated to HIT were at least contributing factors, this case is still widely cited as an example of HIT potentially causing harm.

While the accounts of HIT directly causing patient injury (or even death) are extremely rare, other types of unintended consequences have proven to be important and recurrent themes. These include issues of user acceptance, adverse impacts on clinical workload and workflow, altered communication patterns, and potential over-dependence on the technology.

Exploring these social-organizational issues can rely most heavily on innovation theory, especially in the areas of adoption and resistance.

The Literature on Adoption and Resistance

There is a strong and growing ethnographic research tradition in informatics that is ideal for exploring issues of HIT adoption and resistance. Questions about user's perceptions and attitudes about HIT have been explored extensively using qualitative methods through the work of Diane Forsythe, Nancy Lorenzi, and Joan Ash and her POET team.

These inquiries are supported by a solid foundation of theory. Everett Rogers' Diffusion of Innovations provides the most common framework for health care research on innovation. For example, a National Library of Medicine PubMed search of the medical literature showed over 125 articles with the search term "diffusion of innovation" in the title or abstract. The Journal of the American Medical Informatics Association (JAMIA) finds 37 articles specific to informatics.

The other innovation theories commonly seen in the informatics literature are descended from Ajzen and Fishbein's Theory of Reasoned Action (TRA).

Three offshoots of TRA have been gradually enhanced by Davis, Venkatesh, and others. They include the original Technology Acceptance Model (TAM), a revised theory (TAM2), and a unified theory called the Unified Theory of Acceptance and Use of Technology (UTAUT). Of the three, TAM and TAM2 have the most presence in the literature with 38 PubMed references in titles and abstracts.

All of these theories seek to provide a solid framework to explore how individuals choose to accept or reject a technological innovation. Each theory has its advantages. For example TAM and TAM2 describe a straightforward behavioral model, while the UTAUT provides a mathematical formula to quantify the likelihood of a user’s decision to adopt or reject an innovation.

Rogers' "Diffusion of Innovations"

In addition to the pure scholarship of Rogers' work, I think it is the richness of his framework and the inclusion of organizational factors that explain the Diffusion of Innovation (DOI) theory's popularity in informatics and with qualitative researchers. Aspects of the DOI theory that describe (and sometimes anticipate) the acceptance or rejection of HIT are described below.

1. Rogers lists four characteristics of an innovation that influence adoption:
    a) Relative advantage

        Who actually benefits from the implementation of an innovation is a powerful theme in exploring how users respond to HIT. A frequent refrain among users is that the system is for the benefit of management or the organization and not the clinicians providing the care (and ultimately, the patient receiving care). For example, using complex data templates to enter coded patient observations rather than dictating (or even typing) a free text narrative has enormous organizational benefit, but can slow down and frustrate a physician user.

    b) Compatibility

        In DOI, compatibility refers to the "fit" of the innovation into the social structures, workflows, and values of the users. This speaks directly to how HIT can drastically change long-standing communication pathways (between nurses and doctors for example) or alter how individuals view their work and even themselves. For instance, HIT has been shown to enhance the self-worth of lower ranked staff (unit secretaries for instance) while dramatically reducing that of physicians being asked to perform what they may see as "clerical" activities.

c) Trialability

The scale of most HIT projects does not permit users to "try out" the software or evaluate how things will work for their particular environment. Because user buy-in is critical to an HIT project (especially for nurses, physicians) some organizations provide prototypes or "play systems" to gain trust and acceptance as early in the project as possible.

d) Observability

Observability stresses the need for users to form an opinion about how an innovation may impact them. According to Rogers, the earlier this occurs the better the chances for acceptance. Unfortunately, many HIT projects are rolled out as a "big bang" (all locations are switched over at the same time), leaving no room for clinicians to see how the system performs elsewhere. Phasing HIT implementations to pilot locations can provide an opportunity for potential adopters to observe the innovation, but this can also backfire if the pilot goes poorly.

2. Reinvention

Coming to realize the importance of user reinvention, Rogers extended his discussion in later editions of Diffusion of Innovations. HIT projects are susceptible to failure when users are not allowed to customize systems. Most commercial EHR software provides options for at least some localization of workflows, screens or database content, but organizations frequently fail to appreciate the importance of user reinvention. Instead, many HIT systems are delivered as “vanilla”, and fail to conform to local conditions or user workflows and values.

3. The importance of communication channels and networks.

The first lesson HIT vendors learn in marketing is how to identify the "champion" within an organization. While salesmen seem to know this intuitively, many organizations fail to include formal and in-formal thought leaders in the selection, implementation, and evaluation of HIT. Physicians, especially, are more highly influenced by peers (called

"opinion leaders" by Rogers) than any other form of communication (including journals, training, or mass media and advertising).

4. Individual versus organizational adoption decisions.

Even in the smallest clinic, the decision to implement an EHR is an organizational rather than individual adoption decision. Rogers distinguishes between Optional, Collective, and Authority decisions, and most HIT projects fall under Authority (an organizational mandate) or, rarely, Collective (a consensus within a small physician group, for example).

5. Unintended consequences.

The study of unintended consequences of HIT has almost become a subspecialty in the informatics literature. Examples were given earlier, but Rogers makes the point that even perfectly performing innovations can have unforeseen impacts. An example from informatics is a shift in communication pathways that appear when physicians place orders in a computer instead of verbally interacting with nurses and staff, thus displacing the "rich" channels of verbal and visual communication.

6. Timing (Phases of adoption):

Perhaps the most well known concept of DOI, the phasing of adoption behavior from Early Adopter to Laggard, is not stressed in the informatics literature. This may be because HIT implementations are seldom individual choices to adopt, but instead, institutional choices made on behalf of (or inflicted on) the users.

Svejkism, an Alternative Theory:

While the academic literature present excellent examples of clinicians reactions to HIT (both positive and negative), a paper that stood out for its use of the "real" literature was a case study by Stephen Timmons called "Nurses resisting information technology". Timmons introduces the term "Svejkism" in reference to the novel *The Good Soldier Svejk and his Adventures in the Great War* by Jaroslav Hasek (1973). He finds several resistance behaviors exhibited by frustrated nurses in the U.K. coping with a new care planning system to be analogous to the novel's character Svejk. These include, in Hasek's terms, "equivocal affirmation, practice as performance, an ironical disposition", and of course, "skepticism and cynicism".

Summary and Conclusion: Can You Hear Me Now?

In 2001, the journal Health Affairs surveyed 225 internists about their views on the top 30 medical innovations over the previous 30 years. While many well-known drugs, tests, and surgical procedures made the list, Healthcare IT was not among the thirty (the top 5 were HIV testing and treatment; cataract surgery; PSA testing; long-acting opioids; and anti-depressants).

Are clinicians adverse to innovation? While this is a rhetorically interesting question, I think the more meaningful inquiry is to ask "What kind of innovation do clinicians need?"

When Rene-Theophile Laennec introduced the stethoscope in 1816 (the crude version shown below), there was predictable resistance to this new innovation. According to Neil Postman in his book Technopoly, there was concern that by using the device "Doctors would lose their ability to conduct skillful examinations and rely more on machinery than on their own experience and insight."

Today, we hear this concern echoed in the reluctance of physicians to use computers during patient encounters. Is the objection the same as with the stethoscope? That reliance on machinery leads inevitably to loss of an essential element of care? Or could it be that our tools to

actually use EHRs (keyboards, mice, touch-screens, spotty voice-recognition), are the clumsy equivalent of Laennec's wooden tubes?

Through the 2009 Stimulus Bill and the HITECH Act the U.S. is making an unprecedented commitment to diffuse HIT directly to hospitals and primary care practitioners. Informatics research (informed by work in technological innovation studies) has truly never been more relevant or interesting.

Figure from: Leikind M. The Stethoscope: some notes on its history. Journal of the National Medical Assoc. May, 1955;47(3):177

"There are ninety-nine things you need to know:

Number one: There are more than ninety-nine things you need to know.

Number three: It's more than three.

Number sixteen: At any time the list of things you need to know can be abruptly suspended."

Carlin G. When Will Jesus Bring the Pork Chops? New York: Hyperion, 2004

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See POET Bibliography (OHSU):
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Bishop PJ. Evolution of the Stethoscope. Journal of the Royal Society of Medicine. June, 1980;73:448

Oliver Wendell Holmes: The Stethoscope Song
http://www.ibiblio.org/eldritch/owh/steth.html

Web Sites:

OHSU Provider Order Entry Team (POET)
http://cpoe.org/

National Library of Medicine: Health IT
http://www.nlm.nih.gov/healthit.html

Institute of Medicine: Reports
http://www.iom.edu/en/Reports.aspx

Office of the National Coordinator for Health Information Technology: Home
http://healthit.hhs.gov/portal/server.pt

Blog: National Coordinator for Health IT
http://healthit.hhs.gov/blog/onc/

Agency for Healthcare Research and Quality: Health IT
http://healthit.ahrq.gov

American Medical Informatics Association: Home
https://www.amia.org/

AMIA: "Got EHR" Awareness Campaign Home
https://www.amia.org/content/got-ehr

Healthcare Information and Management Systems Society: EHR Home Page
http://www.himss.org/ASP/topics_ehr.asp

American Association of Family Physicians: Center for Health IT
http://www.centerforhit.org/online/chit/home.html

Certification Commission for Health Information Technology: About
http://www.cchit.org/about

HIT Vendor Sites:

HIT Vendor: Cerner Corporation
http://www.cerner.com/public/Cerner_3.asp?id=128

HIT Vendor: Epic
http://www.epic.com/about-index.php

HIT Vendor: GE Healthcare
https://www2.gehealthcare.com

HIT Vendor: eClinicalWorks
http://www.eclinicalworks.com/

Blog: HISTalk: Healthcare IT News and Opinion
http://histalk2.com/

HIT News:
http://www.healthcareitnews.com/

Figure 1: AMIA's national media campaign to raise awareness of the benefits of HIT.

Figure 2: The HITECH Act.

Health Information Technology for Economic and Clinical Health Act.

42 USC 201 note.

TITLE XIII—HEALTH INFORMATION TECHNOLOGY

SEC. 13001. SHORT TITLE; TABLE OF CONTENTS OF TITLE.

(a) SHORT TITLE.—This title (and title IV of division B) may be cited as the "Health Information Technology for Economic and Clinical Health Act" or the "HITECH Act".

(b) TABLE OF CONTENTS OF TITLE.—The table of contents of this title is as follows:

http://en.wikisource.org/wiki/American_Recovery_and_Reinvestment_Act_of_2009/Division_A/Title_XIII