

Health Information Technologies' Influence on Healthcare Professionals and Society

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On my honor as a University Student, I have neither given nor received unauthorized aid
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Introduction

Medical misinformation has been spreading through social media and groups of people who disbelieve the evidence behind vaccines and diseases. This presence of misinformation creates tension between medical professionals and doubtful social groups. In addition, the history of medical mistreatment against minorities has made these groups much more skeptical of medical advice, including the need to get vaccinated against Covid-19. Addressing medical mistrust in communities of color and establishing trust between healthcare professionals and these groups is vital to continue this effort (Hostetter, 2021). The roles of healthcare professionals have also greatly evolved over the years with the growth of technological advancements in the healthcare field. As such, it is important to ensure that healthcare professionals can efficiently utilize the healthcare information system provided and address concerns that may arise from changes over time.

Considering these changes, it is important to explore the current way technology is used for communication between healthcare professionals and patients and the issues related to them. To better understand the socio-technical dynamics behind healthcare information technologies (HITs), I will use the Interactive Sociotechnical Analysis (ISTA) model to further examine these dynamics (Harrison et al, 2007). Analysis of the feedback on interactions between social groups after introducing new HITs or disruptive technologies will be addressed. The sociotechnical interactions and unintended consequences can be viewed via the feedback loops addressed in the model to explain phenomena in healthcare and hospital systems.

Research Question and Methods

The research question is how healthcare technology has developed over time to examine shifts in communication between HITs, society, and healthcare professionals. This paper

examines the policy and history of how healthcare has adapted or rejected HITs to provide a more general overview of the direction these relations are taking. Unveiled is a clearer picture of the social and technical interactions with HITs. Analysis of patterns, correlations, and trends over time will be examined via the Interactive Sociotechnical Analysis (ISTA) framework to assess the impacts HITs have had on communications over recent decades (Harrison et al, 2007). The research analyzed the feedback loops between the four ISTA interactions and the resulting unintended consequences between social groups due to the introduction of new healthcare technologies. The ISTA consequences are new HIT changes the social system (type 1), technical and physical infrastructures mediate HIT use (type 2), social system mediates HIT use (type 3), HIT-in-use changes the social system (type 4), and HIT-social system interactions engender HIT redesign (type 5). Through research on historical trends and significant issues related to actors in the healthcare system, any patterns in issues or relationships on the influence of technology on healthcare workers and their patients over the development of technology are revealed.

Supportive Background Information

It is important to identify current research to examine how HITs have affected the actors in the healthcare system to understand the analysis done via the ISTA model. When designing technical systems, engineers consider the design criteria to support their purposes. In practice, it is always challenging to know the requirements, cover all use cases, design all the features needed, and gather feedback from stakeholders. For example, several technical challenges were identified when performing usability tests for electronic medical records (EMR). Not only can they be costly or require significant effort to establish, but EMR systems need to integrate with a hospital's current HIT and communicate with other EMR systems to exchange data (Swanson and Lind, 2011). Nurses depend on EMRs to plan for patient care; however, they may ignore

concerns a patient brings up if they deem them irrelevant to the EMR's inputs. In addition, physicians' reliance on information from EMRs when making treatment decisions has the effect of encouraging nurses to prioritize gathering data over patient care. Patient-nurse relationships and interactions between healthcare professionals are affected by innovative HITs (Campbell and Rankin, 2016). Although these challenges are specific to EMRs, most of the issues can be expanded to other HITs.

Disruptive HITs have also led to strained relationships between patients and doctors. Cupit et al. (2019) showed that doctors refer to risk-scoring technology to classify the severity of cardiovascular disease and to make treatment decisions despite the concerns a patient has, such as the painful side effects of the medication. Physicians also found that describing such a complicated situation is difficult for patients to comprehend and decided not to generate a discussion about it. Since patients are not familiar with the judgments considered in the risk-scoring technology due to a lack of clarification from doctors, patients are less willing to be open about their opinions with healthcare professionals.

However, HITs that succeed in communication have been shown to improve patient relations with physicians. For example, as a result of the increase in ways available for patients to retrieve their information, patients and doctors appear to have improved communications with the help of HITs. Unintended risks like increased worry were minimal and benefits such as increased trust between doctors and improved medical knowledge in patients were evident. Improved medical understanding also correlated with patients making fewer appointments. One motivator was that patients began to self-address problems potentially due to expensive healthcare costs. (Ross and Lin, 2003). Clearer explanations and greater access by patients to their health records can provide greater trust and effective dialogue regarding patient treatment.

Interactive Sociotechnical Analysis Model

To better understand the socio-technical dynamics behind HIT, this research uses the Interactive Sociotechnical Analysis (STA) model. The consequences of how HIT is used have greatly affected the healthcare professionals' ability to communicate with their patients and others can be seen through this model. The main feedback loops that will be addressed are new HIT changes the social system (type 1), technical and physical infrastructures mediate HIT use (type 2), social system mediates HIT use (type 3), HIT-in-use changes the social system (type 4), and HIT-social system interactions engender HIT redesign (type 5) (Harrison et al, 2007).

One goal is to examine how unintended consequences arise due to difficulties with implementing new HITs within the existing physical and technical infrastructures. For feedback loops on how social systems mediate HITs, understanding how these interactions affect their work allows us to understand the behavioral changes that affect standard practices and collaboration between healthcare professionals. This feedback necessitates an examination of HIT-in-use changes over time in the social system to understand overdependence on technology affects how healthcare professionals make decisions and their roles (Harrison et al, 2007). This framework will provide a better understanding of how these interactions between HITs, practitioners, and patients will change the way social entities communicate with one another.

There have been previous studies that have applied ISTA when analyzing specific interactions between healthcare professionals and HITs. Holden (2011) examines the impact of electronic medical records (EMR) on the safety of patients and the healthcare professionals working in the cognitive field. Feedback from users on EMRs shows worse collaboration and communication as well as a weaker understanding of the data by the professionals because of the user interface. However, this feedback is bidirectional, as the way the professionals use these

systems are different from the original intentions of the designers. Applying the principles of ISTA allowed Holden to identify major areas that require change, such as the need for multifaceted and interactive systems. Such kind of identification can drive solutions and help predict the outcomes from these changes to achieve better performance and communication. A similar approach can be used to examine a variety of technologies under more complex situations to assess how patients interact with HITs and professionals.

Although most literature reviews have supported the validity of ISTA (Bloomrosen, et al. 2011), some scholars have highlighted weaknesses of the ISTA framework. One aspect that ISTA cannot cover is the specific technological components for HITs. This includes considerations such as the user interfaces or hardware configurations that are important in affecting how professionals use HITs and how users experience the system (Sittig and Singh, 2010). This research will examine potential impacts on how HIT systems and changes to them have been reflected on society and healthcare professionals through the ISTA framework when identifying how communication between them has changed.

Results and Discussion

According to the ISTA framework, the continuous feedback loops to address problems with HITs have historically resulted in unintended consequences that perpetuate a cycle of confusion and hesitant progress. Communication between healthcare professionals and their patients had waves of trust and reluctance depending on how HITs were developed. Between healthcare professionals, shifting roles changed the scope that each job held in the past, usually by providing greater focus on patients while also becoming technology dependent. Surprisingly, external factors, such as the government, had a significant impact on the direction and advancement of HITs in the last few decades and thus affecting how healthcare professionals and

patients perceive technology, especially concerning the rate at which technological literacy lags behind exponential technological change. Nonetheless, HITs have the potential to increase efficiency, reduce human error, emphasize patient care, and address systemic issues within the healthcare system that have traditionally disadvantaged specific populations.

Historical Trends of Healthcare Technology

Before reflecting on current-day interactions, examining changes over history involving healthcare technologies will demonstrate patterns in how society utilizes them. After World War II (WWII), policy changes addressed healthcare practices and technological regulation. Along with the tragedies of war came the fruition of technology, especially in medical knowledge and computers. Expensive and bulky computers were available as companies lifted restrictive patents. Techniques for trauma treatment and managing several patients at once and the development of antibiotic drugs, such as penicillin, reduced mortality rates (Burton, 2020). There was potential in computers to address concerns for medical inaccuracies since medical knowledge could be easily stored and accessed. It would also increase time and attention for physicians to direct to patients instead of compiling medical knowledge or looking up information. As a result, frameworks and long-term policies subsidized hospitals and medical schools to achieve these goals (Kaplan, 1995).

These policies broadened the access to medical care by the general population. During the mid-1960s, Congress established Medicare and Medicaid to provide low-income and elderly populations in the United States with government support for healthcare. This law led to changes in computers to adapt to a greater patient capacity and reduce costs. Before this law, physicians viewed technology as an electronic library, used in a limited way for storing knowledge on diseases and treatments. The use of computers for diagnoses promoted a greater understanding

that would have happened at a more gradual pace without computers (Kaplan, 1995). With greater access to healthcare, healthcare professionals began looking towards computers to communicate with and manage their patients, which grew with the passage of Medicare and Medicaid. Thus, developers created advanced information systems, hoping to improve communication between medical institutions and integrate functions addressing patient care and administration (United States Senate, 2019). With these new information systems, medical institutions could handle a large influx of patients along with a new purpose for HITs.

Complex medical information systems in practice were costly to maintain and develop, driving healthcare costs to increase for patients as an unintended consequence. As these prices continued to grow in the 1970s, the public became increasingly wary of medical institutions, and economic issues dimmed the promise of progress (Saldin, 2011). This phenomenon resulted in medical institutions redirecting their attention to changing their information systems, and reducing costs became the primary goal when developing such systems. Healthcare systems also had to coordinate with other medical services, such as various EMR systems, on a large scale to manage patients with the additional complexities of medical care. Until the 1990s, drastic changes were evident to contain costs to a reasonable amount (Kaplan, 1995). For example, hospitals often substituted outpatient services for inpatient services, which led to increased visits for diagnostic tests and procedures over observation. Most medical institutions could not adapt quickly to new healthcare technologies, leading to the continued use of legacy technologies which may have cost more to maintain (Menon et al, 2000).

There was some chaos in how healthcare providers used technology and concerns with the quality of medical care. Some technology created to lower costs also led to alternative modes of communication that were more convenient between patients and their physicians. Telehealth

technology was an example of moving away from solely information content to better manage patient health by providing more affordable care to individual patients and moving away from the original purpose of gathering information to organize appointments (Whitten, 2006). Despite some positive changes, however, more medical institutions adopted a variety of healthcare technologies without scientific evidence to confirm their effectiveness, even in common medical treatments. There were often errors that affected the results delivered by healthcare professionals due to a lack of regulation and standards, including misinterpretation of lab results from X-rays, mammograms, and other new technologies (Simmons, 1996). Incorrect readings lead to wrong information communicated between healthcare professionals and their patients, affecting how patients perceived the quality of healthcare they were receiving and how they were willing to trust the doctors. The issues with technology within the healthcare system demonstrated how changes in HITs reflected the needs of their users but can lose control without oversight. These issues show an ISTA Type 5 consequence since an overdependence on technology grew even though healthcare providers still found these systems complex. The rapid transition from paper-based systems to HITs without preparation created automatic reliance on new technical systems. Fortunately, the 1990s brought reflections on policies to adapt to the issues with healthcare and technology (Uphoff and Krane, 1998). The government and other regulatory agencies began to create new standards and request medical institutions to release reports on their use of technology and patient care, creating a framework of considerations for medical institutions when adopting technology in the 21st century (United States Senate, 2019).

The trends from the 1950s to the 1990s have shown the key feedback loops and interferences that affect communication between patients and healthcare professionals. As the needs of healthcare professionals change, technology reflects these developments. This

transformation was often driven by external interference, especially with government regulation that affected how medical institutions functioned, influencing the purposes instilled into technology. Unintended consequences are also factors that result in major changes; for example, an emphasis on management in these programs to reduce costs was an unintended consequence of rising costs due to more expensive patient care.

Healthcare Technologies Issues in the 21st Century

Previously, communication in healthcare technologies was emphasized to cut costs with management and administration. These technologies were developed at such a varied and rapid pace that medical institutions began using their self-tailored systems, bringing concern to the technology used to assess patient health and influence the decision of healthcare professionals. Now with more regulations and standards in place, improvements in healthcare technologies lead to changes in how healthcare professionals interact with each other along with their patients.

The roles of healthcare professionals shifted greatly with the availability of healthcare technologies. Physicians' roles were focused on creating solutions based on technology and its treatments rather than administration and managing data. Tedious tasks that took away time to focus on patient care, i.e., replacing bedpans and organizing data via paper records, were substituted with technology. Jobs took on higher, more creative tasks that shifted the jobs of physicians to spend more time on treatments (Landry et al, 2005). New HIT began introducing changes to the social system (ISTA type 1 unintended consequence) by shifting the traditional workflow of medical institutions to have more tasks done with technology, thus creating less tedious work for healthcare providers in exchange for a focus on patient care and treatment research. However, there were unexpected barriers due to several factors, such as having

healthcare professionals, who are not as technologically literate as developers of HITs, suddenly forced to use technology with little or no training.

During the rise of HITs in the early 2000s, several concerns about HITs' unintended consequences rippled through the public and healthcare providers, especially among patients. As people were wary of rising healthcare costs and increased use of novel technology, barriers hindered the implementation of HITs. A study found that the availability and cost of patient safety technology and priorities for scarce resources in an information system that would minimize the importance of patient safety were the greatest concerns. These concerns also included communication between healthcare providers and patients in how technology would affect patient safety (Akins and Cole, 2005). While new HITs started transforming communication and interactions between patients and healthcare professionals (ISTA type 1), unfamiliarity and novelty of potentially complex information systems created resistance to changes that would allow smoother implementations of HITs. The need for regulation and government intervention grew to overcome these barriers.

Under President George W. Bush's administration, the federal government began creating more legislation to promote HITs and address challenges at this time, such as electronic medical records (EMRs). EMRs could provide the medical history of patients quickly, fixing issues of information gaps between healthcare professionals and patients that their paper-based counterparts had. Medical institutions used technology to cut administrative costs. Later, their focus shifted to improving healthcare quality with such technology when the public began to have doubts about technology due to pervasive expensive medical costs. The goals were to promote EMR use in medical institutions and facilitate health information exchange. However, issues arose due to the lack of federal policy and business interests. To serve the interests of

residents and due to their position as policymakers, states developed their healthcare information systems and experimented with their technological platforms and management models. State policies arose due to the lack of federal policy; however, concerns about conforming to a federally established standard and model for HITs deterred states from further experimenting with improving policy and adopting more technology. Similarly, hospitals, insurance companies, and other establishments were in a competitive space, making them reluctant to share investment costs and communicate data between them (Beaton, 2008). Since these establishments were refusing to divulge information between them due to such interests, communication proved to be a challenge when patients had to transfer between these institutions with different HITs. Healthcare professionals were frustrated when accessing patient data from HITs that they were not using, and tensions were created between each other.

Employing the ISTA framework, the state and federal governments are addressing problems within ISTA type 2, resulting in concerns growing within HIT-in-use changes social system (ISTA type 4). Federal policy to promote communication and exchanging data via HITs was challenging to implement since states enforced their own technologies and standards. With the increased diversity in HITs and decentralization of standards between states, there will be increased conflict when the need for a centralized HIT system arises. The exchange between levels of government and technology is creating a feedback loop between these two ISTA types due to issues of delayed legislation with an exponentially advancing field of technology.

To facilitate the exchange of information and communication, the federal government enacted legislation to achieve this. In 2009, Congress passed the Health Information Technology for Economic and Clinical Health (HITECH) Act to promote the integration of HITs by healthcare providers (HIPAA Journal, 2021). To resolve ISTA type 2 problems, government-

funded programs invest in HITs and educate patients on HIT benefits. This response fits the ISTA type where the social system mediates HIT use (ISTA type 3). With the lack of communication between healthcare providers, the government invested in EMRs. These investments led to medical institutions adopting EMRs as they trained more medical professionals to utilize such technology. A year later, the Office of the National Coordinator for Health Information Technology (ONC) published the Standards and Interoperability Framework to create standards that developers of HITs could follow (Escobedo et al, 2011). This attempt was to mitigate ISTA type 4 problems to ensure security and quality while enforcing the ease of information exchange. However, due to the continuously rising cost of healthcare, there is a shortage of funds that medical institutions could use for HITs. The lack of investment in proper HITs is another pervasive issue seen, affecting the quality of communication between healthcare professionals and patients. For example, older and less user-friendly systems would make access to information problematic and tedious, while adding information could result in errors depending on the interface.

Despite the concerns with these issues, investments into HITs rendered positive effects to help citizens who typically had trouble accessing healthcare, especially various communities of people of color who face several challenges when accessing healthcare. For example, one underserved community that can potentially benefit from telehealth and telemedicine is the Hispanic and Latino populations. Although they use the same technologies as non-Hispanic White, ISTA type 3 consequences differ. Cultural and linguistic factors affect how these communities approach healthcare and technology alike, determining their accessibility and informed decisions. Telecommunications address language barriers that often create a gap between healthcare professionals and these communities, providing accessibility for Hispanics to

reach healthcare providers who can speak their language (Agate, 2017). Telemedicine could also provide access to healthcare practices that respect their culture and collaborate to find treatments that help them while maintaining their beliefs and customs.

Limitations and future research

One of the limitations of the research was the ISTA framework used. Through this framework, analyzing the interactions and feedback loops between HITs and healthcare professionals and each other provided explanations for the behaviors and policy changes in the realm of HITs. However, the ISTA framework proved to be limited when analyzing patients and healthcare professionals since the five ISTA types treat HITs as the intermediary between healthcare professionals and patients, but it is difficult to analyze relations between healthcare providers and patients directly. Another limitation is the general scope of this research question when there are several nuanced issues and roles within the healthcare system between different social groups. This general question is answered by looking at the overall view of the healthcare system, with several exceptions and trends that exist when examining more specific relations between nurses and patients or software engineers and doctors.

To overcome the limitations, future researchers should observe more focused areas addressed in this paper or other topics related to how technology impacts factors in the healthcare system. One topic is examining the role and relationship engineers of HITs have with healthcare professionals, or the lack thereof, and how to clear communication between them. Research currently addresses the issues between actors in a healthcare system, such as patients and physicians, but less exploration has resolved conflicts between programmers and healthcare professionals (de Jong, 2014). Diving into the disconnect between doctors and programmers may provide insight into what both sides need when designing or using HITs.

Conclusion

HITs revolutionized the healthcare system, transforming the way healthcare professionals exchange information and communicate with their colleagues and patients. EMRs, for example, have allowed for greater mobility in terms of treatments, more options for patients, and more secure distribution of medical knowledge. As healthcare costs grow and the costs to update legacy systems and train healthcare providers to use such technology rise, ongoing challenges will lead medical institutions to improve technology-dependent data that healthcare providers and patients have trouble understanding and adopting. These issues include diverse HITs with minimum standards, a lack of enforcement, and dated policies. As the United States continues forward with new HITs introduced into the market, engineers, legislature, and medical institutions must come together to overcome these challenges to allow HITs to assist them and not act as a barrier.

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