Implementation of Semantic Search to Support Clinical Decision-Making

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The Problem

Problem statement

Physicians who previously used information resources such as paper patient charts, colleagues, textbooks and direct patient communication for problem solving purposes are using medical human performance technologies (HPTs) such as computer physician order entry systems and Electronic Health Records (EHRs) in hopes that a central patient information resource can improve efficiency (Tawfik & Kochendorfer, 2015, pp.270, 272). Instead, the practitioners in the case study were having trouble accessing information that was embedded within the electronic patient charts due to "usability problems and information overload" (p. 271). Research has shown that these kinds of issues cause delays in diagnoses and increase the possibility of provider error (p. 272). The partners in this case study developed a "semantic search system to navigate the electronic health record interface" and support physician decision-making and patient care (p. 274). They have rolled it out, but must continue to fine-tune the technology and win over the end-users (pp. 274-277).

Context of the problem

The problem begins in a "large, land grant hospital located in the Midwestern region of the United States" (Tawfik & Kochendorfer, 2015, p.270). This comprehensive health care system is part of the University of Missouri. The scenario affects the health care providers as well as the patients. Computer Physician/Provider Order Entry (CPOE) refers to any system in which "clinicians directly place orders electronically, with the orders transmitted directly to the recipient. As recently as 10 years ago, most clinician orders were handwritten…[but] the vast

majority of hospitals and most outpatient practices now use some form of CPOE. CPOE systems were originally developed to improve the safety of medication orders, but modern systems now allow electronic ordering of tests, procedures, and consultations as well" (Nanji, Seger, Slight, Amato, Beeler, Her, Dalleur, Eguale, Wong, Silvers, Swerdloff, Hussain, Maniam, Fiskio, Dykes, & Bates, 2017). The context for this case study grew during the reading of it: "After just 1.5 years, the sematic search capability was implemented and launched at approximately 100 health care organizations across the country" (Tawfik & Kochendorfer, 2015, p. 278). Now, the context is national and would include many different sizes of institutions with a variety of cultures. A case could be made that the context is as broad as "the U. S healthcare industry." In fact, "In the past decade, healthcare organizations have greatly accelerated their investments in information technology. The US Health IT market in 2011 was estimated to be $40 billion and expected to grow at 24 % annually for the next few years" (Deokar & Sarnikar, 2016, p. 733).

The characters

At the outset, the characters who play a part in this case study include: physicians; patients; University of Missouri's hospital system; Cerner, an international healthcare IT company located in Kansas City, MO; Tiger Institute for Health Innovation's R & D sub-organization (called The Living Lab), which is a collaboration of University Missouri-Columbia, the research lab of University of Missouri School of Information Sciences & Learning Technologies (SISLT), and Cerner (this collaboration resulted in the Information Experience Lab which promotes the use of both theoretical and practical experience in developing and testing EHRs and in training providers to use them) (Tawfik & Kochendorfer, 2015, pp. 270-271). Also, important to the process is the Health Information and Management System Society (HIMSS),

which sets standards by which to evaluate HPTs. Later in the case study, other characters emerge: developers of the intervention; early adopters and product champions (specifically physician product champions); other providers/users like nursing staff, pharmacists, hospital staff and healthcare workers; and other healthcare systems ("over 100 healthcare organizations across the country") (pp. 277-278).

The Issues

"Over the past decade, Electronic health records (EHRs) have emerged as a foundation of health IT implementations in the US" (Deokar & Sarnikar, 2016, p. 733). In this case study, user training and developer testing for past EHRs had been hampered by the lack of access to actual patient data, since developers did not have permissions/access to authentic data and had to rely on simulations. In addition, because HPTs had been designed from a computer and information perspective, rather than a user perspective, usability and human-computer interaction were an issue. (Tawfik & Kochendorfer, 2015, pp. 271-272). Difficulty navigating the interface resulted in extraneous load, or additional cognitive effort for the user (p. 273). Extraneous load on the system created a sluggish information retrieval process, which required additional searches and increased cognitive effort on the part of physicians/users to get the most out of the system at a time when they should be concentrating their efforts on understanding the condition and treating the patient (p. 273). These problems agree with the research, which has shown mixed outcomes as to the effectiveness and success of EHRs, resulting in the presentation of (inadvertently) misleading information to providers and a decline in the level and quality of patient care. (p. 272).

A semantic search system was developed to address these concerns, but early testing revealed design flaws that limited searches, resulting in incomplete information being given to providers. Beta testing revealed than some had a tendency to trust the system too fully, thereby make hasty diagnoses without all of the correct information. Others were distrustful of the technology due to the limitations of the search capabilities and this mistrust was a concern for the impending launch of the improved technology (Tawfik & Kochendorfer, 2015, pp. 274-275). Finally, the semantic search system was implemented and rolled-out in one location and then in many. Currently, the system is in place in over 100 healthcare organizations, however only 20% of the clients conduct over 80% of the sematic searches, and these users are predominately from the original launch site (p. 278).

The Facts

In my initial reading of the case, I barely noticed the part about the Health Information and Management System Society (HIMSS) model, a measurement indicating the effectiveness of HPT initiatives because the article did not place much emphasis on it. It would have been helpful to hear more of a general description of the instrument: what sort of data is collected? How are the number rankings determined? Even the wording is awkward, “The HIMMS is an important measurement because it describes various stages and an organization’s maturity and ability to employ technology within healthcare” (Tawfik & Kochendorfer, 2015, p. 272). They didn’t revisit the topic in the portion of the case study that was made available here, so we don’t know if the measures taken made a difference in ranking, or not, but since it does not explain how the score is calculated, it felt a bit like useless information.

Also the section on how semantic search works did not stick with me (even if they explained it well). As I look at it again, I question the Smart Ranking technology, "Semantic search understands the context and usage of each concept and thus attempts to promote documents that are most pertinent to the user" (Tawfik & Kochendorfer, 2015, pp. 276-277). If they are going to give us this detail, I would like to know more about how it "understands the context and the usage of each concept" because this is a point where providers are really relying on the technology for a human skill: discernment. (p. 276-277). Context may be related to the clinical significance score, discussed on page 277, but the authors do not link the two, so it is unclear.

In addition, they discuss how EHRs replace patient records and the physician ordering system replaces paper prescriptions etc. but they don't discuss the part of the HPT that replaces diagnosis resources/supports decision-making, such as colleagues and textbooks (Tawfik & Kochendorfer, 2015, p. 273)? The question here is: Is it the search function that provides this service? Or is it the EPSS, the electronic performance support system, mentioned on page 272? They do not define the EPSS, so this is confusing.

There are a few key facts to consider. First, in beta testing of the semantics search system, poor consideration to the usability produced misleading results when physician searches of the EHRs were incomplete. This fact demonstrates the dangers that can occur when technology replaces clinical judgment. Another issue is what happens to the existing processes during implementation of new technology? Usage of the current system must not be interrupted. Also, practitioners are already unhappy with retrieval time. Would semantic searches increase the slowdowns, resulting in lower usage by providers? (Tawfik & Kochendorfer, 2015, p. 275)

The authors discuss other implementation project concerns: information retrieval is hampered by the patient handoff procedure and in cases where there must be many updates to the patient's record, but were these problems corrected (p. 274)? Finally, it is unsettling that systems such as these tend to have a 30% failure of EHRs in supporting physicians, "navigation and the information seeking process alone may account for 20% of diagnosis time" (Tawfik & Kochendorfer, 2015, p. 272). With statistics like that, the implementation team has an uphill battle ahead.

We are not given some other key information that is needed for the analysis of this case study. Though the technology and the people are discussed, the infrastructure is not mentioned. Also, the leadership at the top of the organization is not detailed and there is no information about the strategic plan or how this technology plays into the bigger scheme of the organization. Most likely, leadership and organizational commitment above the developer level can be assumed since this process is costly and requires significant change and commitment, but it is not clearly outlined.

The Feelings

I was interested in this case study because I can see that humans have limitations and computers can help most people do better at most jobs, but I struggled with this assignment. The case study was broken into key concepts with headers to guide the reader. However, it was difficult to unearth the chronology of the intervention. I had to make my own timeline because it was often difficult to discern which stage of the process was being discussed. I was left wondering if Cerner partnered with the other two for the original intervention (the EHR) or just

for the semantics search? It was also confusing that they used the word "cognitive" for human brain functioning as well as for computer processing. This was particularly unclear in the section called "Cognitive Load and Physician Problem-Solving" on pages 272 and 273, where they discuss the cognitive load in terms of the physician's brain side by side with "the extraneous cognitive load within an HPT" or the "information overload within the system" (Tawfik & Kochendorfer, 2015, p. 273). The case study left me wanting to know more about many aspects of the project and the organizations involved.

The Angles

Looking at the problem from the viewpoint of the various stakeholders is important. The physicians/providers are in a vulnerable position because they want to be more efficient, and HPTs promise greater efficiency, but their work is high stakes work. With such high stakes, they cannot afford to place their trust in a faulty system. As for the developers (encompassing all three partners in the development), they have been very conscientious to get stakeholder feedback and resolve issues as they arise (Tawfik & Kochendorfer, 2015, p. 278). They know the potential good that can be done with their new system, so it must be frustrating that 80% of the searches are being done by 20% of the users (those from the original launch site), indicating that adoption of the product is likely to require more change catalysts/change management at the other numerous locations (p. 279). Patients have not been heard from here, but I am sure some of them would be horrified to think that their diagnosis was at the mercy of technology, while others would find comfort that computers may be helping to eliminate human error. The physician champions and early adopters must feel pretty good about their contribution—it seems

that the intervention has been adopted most successfully where they have exerted their efforts, at the original site.

The Resources

In "Factors that Influence the Implementation of E-Health: A Systematic Review of Systematic Reviews (An Update)," Ross, Stevenson, Lau, and Murray highlighted the resources which are most necessary for effective HPT implementation. Suitable infrastructure is critical, including: "electricity supply, available bandwidth, access to reliable internet connectivity, access to computers, electrical power, and access to phone lines and mobile phones" (2016, p. 8). In addition, there should be time set aside for quality training of those who will be using the technologies, along with appropriate job aids and other on the job learning strategies such as just-in-time learning and blended learning (to include online or eLearning resources) (Ross et al., 2016, p. 8; Van Tiem et al., 2012, pp. 262-263 & 270). Lack of training and ongoing technological support is a major barrier to successful implementation of HPTs (Ross et al., 2016, pp. 8-9). In addition, carefully planned change management is essential, which involves "planning, implementation, and sustaining change" (Ross et al., 2016, p. 9; Van Tiem et al., 2012, p. 67). An important part of this process is "clear, consistent, persuasive, and well-supported communication" (Van Tiem et al., 2012, p. 72). Finally, people are integral to change interventions, for example: change agents, early adapters, and champions (pp. 68-69). Physician champions are the best choice to advocate for change because "physicians play a key role in clinical processes and are among the most affected by workflow changes. Also, in many cases resistance to process change has been from physicians" (Deokar & Sarnikar, 2016, p. 740).

Considering the resources needed to implement HPTs, change managers for this case study are in a good position. The infrastructure is obviously in place since all of the locations are already running technologically advanced applications. In the initial roll-out, change management personnel were recruited and in an attempt to mitigate workflow interruptions, communication and training were an important part of launch: "the rollout employed various means to communicate the benefits and features of the technology…short multimedia videos were provided to instruct physicians about the availability and embedded functionality" within the product, and "directed emails" were sent to the entire hospital staff to educate them as to the features of the semantic search system (Tawfik & Kochendorfer, 2015, pp. 277). The case study mentions that a feedback function within the system that allows users to communicate with developers and implementers (p. 278). Much of the groundwork is already laid for improvements in the implementation at other sites.

The Recommendation

This case study covered a lot of ground, trying to set the stage for the final discussion of problem and solution. In order to make recommendations, it is important to narrow the discussion to the two-fold problem of fine-tuning the semantics system technology and winning over the end-users in the secondary markets. The initial launch was fairly successful, and the secondary locations are already running the technology but are not using it as often as they could. The recommendations here focus on improving acceptance of the system in the secondary locations.

Van Tiem, Moseley, and Dessinger explain that certain conditions are necessary for manage change successfully. Every project can benefit from "focused alignment through clear objectives" (Van Tiem et al, 2012, p. 71). Ross, et al repeatedly found that "end user input in the design and development of e-health technologies should be considered as a way of overcoming barriers of adaptability" (2016, p. 7). In the initial roll-out of the semantic search system, the developers made end-user experience a clear objective and allowed input through formative feedback mechanisms; this model should be repeated in other location where the technology is already on board (Tawfik & Kochendorfer, 2015, pp. 274-275). In addition, it is clear that a major need in the successful implementation of performance interventions is the "right people," and based on the limited information given in the case study, it seems that the developers focused on employing change agents, identifying and encouraging early adopters, employing the use of physician champions to implement change at the first site, enjoying the support of sponsors within the leadership of the organization, and gathering feedback from end-users (Van Tiem et al, 2012, p. 71; Tawfik & Kochendorfer, 2015, p. 277). This model should be repeated at subsequent locations. Using an appreciative inquiry approach, local change agents can build on what is already going well (Van Tiem et al, 2012, p. 70).

The Lessons Learned

This case study demonstrates the importance of a few human performance improvement interventions including continuous improvement, change management, and organizational communication. "Continuous improvement is an ongoing systematic process to assure, maintain, and improve processes, products, and services based on predetermined standards and customer satisfaction" (Van Tiem et al., 2012, p. 305). Since the initiation of their first EHRs and the

CPOEs, the organization has been hearing concerns and responding to them, resulting in a rigorous process to improve performance support systems, including the introduction of the sematic search system to combat usability problems and information overload (Tawfik & Kochendorfer, 2015, p. 270). In a similar technological roll-out, an administrator commented, "If we focus on making the software as invisible as possible to the workflows, we'll have better luck getting the physicians to adopt the systems-if they're not using it, it's really just an I.T. experiment, and no one wins in that case" (Gillespie, 2012, p. 48).

The roll-out of the new technology was most successful in the initial location, where change management was given attention: obviously, change management can make a big difference, and change management was clearly a part of the process from an early stage since they already had a list of early adopters from previous technology launches (Tawfik & Kochendorfer, 2015, p. 277). Finally, organizational communication is essential to the success of any intervention. The case study shows how information systems can be integral to the success of interventions—their whole semantics search system was designed to use "cloud-based services" and technology to alleviate cognitive overload and result in access to important information to aid in patient care; they used emails for internal marketing and training; and they listened to the suggestions of end-users and physician champions throughout the initial roll-out (pp. 274 & 277).

In my own experience, I have experienced a feeling of alienation at times in our current church. I am used to smaller communities where there's no need for an app to "stay connected." Attending a larger church means being a part of an organization that often functions more like a business than a community. The need for this is understandable; I'm not sure of another way

they can do their work effectively, but I sure wish I could find one. For me, there's a sense that the strategic plan and "staying on message" can get in the way of organic change. In the practical sense, the flow of information is stemmed to prevent overload, but sometimes that means the ball is dropped when change rolls out (example: the new website and app made it so that the basic information is difficult to find, all in the name of a "clean interface"). Working under a business model should keep the focus on continuous improvement and quality, and organizational communication is critical. For example: the organization continues to change and grow, yet the church calendar only features the regular weekly activities and rarely reflects the events that change week to week. If the situation continues like this, people will stop using the available technology and rely on weekly announcements and regular emails, or simply miss out on opportunities. Even this situation is echoed in the case study, proving that people have a need for trustworthy and usable technology.

References

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