



Benefit or burden? A sociotechnical analysis of diagnostic computer kiosks in four California hospital emergency departments

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ABSTRACT

High expectations for new technologies coexist with wide variability in the actual adoption and impact of information technology (IT) projects in clinical settings, and the frequent failure to incorporate otherwise “successful” projects into routine practice. This paper draws on actor–network theory to present an in-depth, sociotechnical analysis of one such project – a computer kiosk designed to diagnose and expedite treatment of urinary tract infections (UTI) in adult women. Research at a hospital urgent care clinic demonstrated the kiosk program’s effectiveness at diagnosing UTI and reducing patient wait times, and the kiosk was subsequently adopted by the clinic for routine patient care. However, a study promoting the adoption of the device at emergency departments (ED) was characterized by persistent staff resistance and lower-than-expected patient eligibility for kiosk-assisted care. The device was ultimately abandoned at all but one of the new sites. Observations and interviews with ED staff and the design/research team were conducted at four California EDs between April and July 2011 and point to conflicting understandings of evidence for the device’s usefulness and reasons for its (non)adoption. The kiosk program’s designers had attempted to “rationalize” medical work by embedding a formal representation of triage practices in the kiosk’s software. However, the kiosk’s “network” failed to stabilize as it encountered different patient populations, institutional politics, and the complex, pragmatic aspects of ED work at each site. The results of this evaluation challenge the persistent myth that *a priori* qualities and meanings inhere in technology regardless of context. The design and deployment of new IT projects in complex medical settings would benefit from empirically informed understandings of, and responses to, the contingent properties of human–technology relations.

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Introduction

The early 21st century has witnessed rapid proliferation of information technology (IT) devices and systems in hospitals, clinics, and other medical settings. Health IT is widely expected to expedite and improve medical services and to promote the use and spread of evidence-based medicine (EBM). Recent health IT products include electronic medical records, mobile phone applications, computerized check-in systems at hospital and clinics, and patient decision aids. The hopes invested in these increasingly ubiquitous technologies are far-reaching, as demonstrated by the following

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announcement from the U.S. Department of Health and Human Services’ web site: “Widespread use of health IT can...make our health care system more efficient...expand access to affordable care; [and] build a healthier future for our nation” (Services, 2011).

High expectations for new technologies, however, coexist with wide variability in the actual adoption and impact of health IT projects, and the frequent failure of “successful” projects to be incorporated into routine practice (Christensen & Remler, 2009; Murray et al., 2011; Poon et al., 2006). Decades of research on the use and spread of new technologies have not resulted in sufficient in-depth empirical investigations of how and why new technologies are resisted, abandoned, or altered by users after their initial adoption at workplaces (Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004). Introducing new technological devices or systems in medical service delivery settings is more often than not an uneven process – rife with unintended consequences (Ash, Berg,

& Coiera, 2004), stubbornly resistant to simple predictions of success or failure, and rarely amenable to determinist explanations of cause and effect. This is primarily because human–technology interactions are always contingent on complex and interacting social, technical, and institutional processes and structures.

This case study illustrates the challenges of technology implementation when users and designers differ in their understanding of what constitutes a workable or “successful” device or system. The object at the center of the story is a patient-facing computer kiosk programmed with an algorithm designed to identify women with a high likelihood of having a simple urinary tract infection (UTI), or cystitis, through a series of questions presented via audio and touch screen. The goal of the kiosk program was to reduce the amount of time a woman with UTI symptoms spends waiting for an examination in acute care settings such as hospital emergency departments (ED) and walk-in urgent care clinics. The device's prototype was developed, tested, and adopted for routine use at a university hospital's urgent care clinic, which serves patients seeking same-day services who do not require immediate medical attention. Approximately half of all women referred to the kiosk at the clinic were found eligible for kiosk-assisted care, and nearly all of those patients reported being satisfied with the experience (Aagaard, Nadler, Adler, Maselli, & Gonzales, 2006).

Based on this initial success, the kiosk seemed to have strong potential for use in other clinical settings where UTIs are routinely treated, so a study was developed to promote and test its adoption at four hospital EDs. Results of a randomized trial at three of the four EDs confirmed the accuracy of the kiosk algorithm's diagnosis and treatment recommendations, and demonstrated that it reduced wait time among women who received kiosk-assisted services (Stein et al., 2011). However, attempts to integrate the kiosks into routine practice encountered unexpected difficulties at all sites, including uneven recruitment patterns, staff resistance, and lower than anticipated patient eligibility for kiosk-assisted services. Upon completion of the two-and-a-half-year study period, only one of the EDs was interested in retaining a kiosk.

This paper asks why such a promising device was not adopted as predicted, despite sustained efforts by the design/research team and staff at participating hospitals who signed on to promote its use. We begin by describing the theoretical approach to technology that informs this study's methods and analysis. Then, we present an in-depth account of the kiosk's (non)adoption process, drawing on multiple perspectives to illustrate how the device's “fixed” material and representational qualities were destabilized as they encountered different patient populations, institutional politics, and ED work processes at each site. We conclude with a brief discussion about how the design of new IT projects in complex medical settings would benefit from empirically informed understandings of, and responses to, the emergent, contextually embedded relations between humans and technology.

A sociotechnical approach to IT use

To analyze how a presumably simple tool was undermined through its interaction with the complex, pragmatic requirements of patient care in four EDs, we draw on actor–network theory, or ANT (Callon, 1986; Latour, 2005; Law & Hassard, 1999). ANT rejects the conventional definition of technology as a domain of value-free tools with stable properties and capabilities that determine their use and impact. Instead, it conceptualizes technology as actively shaping, and being shaped by, work practices, human relations, and institutions. In ANT terms, an actor is a human or non-human (e.g. technological device or system) that has interests and acts (or is spoken for) in order to align its interests with those of other actors. When a group of actors is persuaded to adopt the same interests, an

actor–network is created. Networks are often unstable and always heterogeneous, meaning they are comprised of people, things, institutions, practices, and representations. In this framing, people and things do not have essential, *a priori* properties, nor do humans and non-humans reside in ontologically distinct domains. Rather, all actors become what they are as a result of their position in a network or networks.

The creation and stabilization of networks takes place through a process referred to by ANT as “translation”, in which a group of actors comes to agree on common definitions and roles and takes up the task of enlisting others in the network's project. Translation processes that are particularly relevant to our analysis of the kiosk include “problematization” – in which alliances among actors are formed and a problem and its solution are defined (e.g. the UTI kiosk as solution to the problem of ED overcrowding), and “inter-essement”, in which actors are persuaded to agree with the primary actor's understanding of the problem and their roles in the network are negotiated (e.g. ED staff, patients, physical layouts, workflows, and the kiosk itself are convinced – or not – to accept the roles offered to them in the network). As a dynamic network comprised of an array of interacting human and non-human actors, a technological device is unlikely to be stable in its performance or effects in multiple contexts – particularly before its network has been built and become taken-for-granted.

Despite the insights offered by ANT and the qualitative research methods on which it is based, research evaluating the adoption and impact of health IT continues to be dominated by experimental and quasi-experimental study design. These approaches tend to produce oversimplified readings of the social contexts in which technologies are introduced. They also fail to account for tacit assumptions and power relations that are often built into IT systems (Forsythe, 1996), or the emergent, co-constituted properties of technologies and their human users. An over-reliance on experimental design can thereby lead to disjuncture between predicted and actual uses of new technologies. In contrast, a “sociotechnical” approach, informed by ANT, draws on qualitative methods to study technologies in the midst of the complex social and material networks that constitute – and are re-shaped – by them (Berg, 1999; Berg, Aarts, & van der Lei, 2003; Latour, 1988; Timmermans & Berg, 2003). Ethnographic methods can be particularly helpful in explaining implementation difficulties, non-use or unintended outcomes of technology projects (Cresswell, Worth, & Sheikh, 2010; Greenhalgh & Russell, 2010), and are increasingly recognized as a valuable approach to evaluating and building health IT projects and health care more broadly (Forsythe, 1992; Greenhalgh & Swinglehurst, 2011; Kaplan, 2001). In using ethnography to examine kiosk use and non-use, we examine how a material device and its adjoining representational system became entangled in, and were transformed by, the complex sociality and decision making processes at several busy EDs.

Methods and analysis

Setting

Observations and interviews were conducted at four California hospital EDs. See Table 1 for a brief description of each hospital and the dates of its active kiosk use. All sites are identified throughout this report with pseudonyms.

Kiosk and UTI program design

The kiosk was a freestanding device much like an ATM in appearance, with a touch-screen computer that was accessible to most adults in a standing or seated position. The UTI module

Table 1
Participating hospitals.

Hospital	Description	Annual ED visits	Period of kiosk use
Home hospital	Urban, public university-affiliated hospital. Affiliated with research/design team's home institution.	40,000	Sept. 2008–ongoing
East hospital	Urban, public “safety net” hospital with high proportion of uninsured and publically insured patients.	58,000	UTI program not approved
Valley hospital	Non-profit hospital that serves a large agricultural region whose population has disproportionately high rate of poverty and poor health status (Tu et al., 2009).	110,000	Oct. 2009–June 2011
County hospital	Urban, public “safety net” hospital that provides approximately half the uncompensated care in its county (Christianson et al., 2009).	75,000	Nov. 2008–Dec. 2009

offered the user a choice between Spanish and English language, and low literacy patients were assisted by an attached handset with an audio version of graphic content.

The computer algorithm embedded in the kiosk was modeled on existing telephone-based treatment programs for UTI (Aagaard et al., 2006). The program was designed, tested, and revised by two physicians, RG and JS, the lead investigators of the program's implementation and effectiveness study and co-authors of this paper. Eligibility for computer-assisted treatment was limited to women aged 18 to 64 who had had a previous UTI, were experiencing painful urination, and did not have symptoms that could indicate a more severe or complicated condition. Patients who interacted with the kiosk were asked a series of questions with yes/no and multiple-choice answers. See Stein et al. (2011) for a more complete description of the algorithm, patient eligibility criteria, wording of questions, and screen design.

Participants and data collection

To explore the range of factors contributing to the process and politics of kiosk adoption, the first author (SA) visited all four kiosk sites, observing clinical and research activities for a total of 20 hours between May and July 2011. Observations focused on waiting room, patient check-in and triage activities. Between April and July 2011 she also attended research meetings and conducted 31 semi-structured interviews with ED staff and researchers, including nine members of the research team, 10 on-site physician-researchers and research staff, and 14 triage nurses. Research team interviews included four interviews and numerous informal conversations with the kiosk program's lead designer and investigator (RG).

The design of this study included interviews of kiosk users (patients), but this was not accomplished because the kiosk was not in active use at two of the four sites, and patients were not referred to the kiosk during observations at the other sites. Thus the primary focus of this analysis is on staff reluctance to refer patients to the kiosk, rather than patients' experiences interacting with the program. We acknowledge, however, that many questions about the kiosk's meaning and value will remain unanswered until patient perceptions and experiences with the device are explored.

Interviews were semi-structured and lasted 30–60 min. Participants were asked to describe their involvement with the study; the specific processes and conditions that they felt contributed to the use or non-use of the kiosk at each site; and their perception of the success or failure of the kiosk project more generally. All interviews were audio recorded, except for those conducted on an impromptu basis with nurses while they were on shift, and in one instance when a participant requested that the interview not be taped. Interviews were transcribed and the names of participants were replaced with a code; only the first author had access to the coding system. Given the difficulty maintaining

anonymity on a project with only four sites and a limited number of staff, most interviews included a period during which the audio recorder was turned off and the interviewer took notes. These notes were edited to remove identifying details and were stored on an encrypted computer, along with interview transcripts and field notes.

Other sources of data included the research team's funding proposals and reports generated before and during the kiosk study; meeting notes; and manuscripts and publications reporting study findings. The study was approved by the UCSF Committee for Human Subjects Research.

Analysis

To understand the perspectives, experiences, and practices of the various actors involved in implementing the kiosks, an iterative process of coding, thematic development, and interpretation was followed (Coffey & Atkinson, 1996; Denzin & Lincoln, 2005). Through repeated reading of the data, recurrent themes and patterns were identified, focusing on kiosk research-related activities at each site, particularly reasons for use and non-use of the kiosks. Descriptive categories were then developed for each emerging theme, and data fragments were assigned codes and a site identifier to enable individual site analysis as well as cross-site comparison. After codes were assigned to the data, analysis was further developed through engagement with theoretical concepts, as described above. This stage included making sense of ambivalent and contradictory statements and practices.

All authors except SA and LS were members of the research team that designed the kiosk program and guided its implementation. SA is an anthropologist who was asked to join the team in the last month of the project in order to conduct this study. She interviewed all members of the study team, which means that all co-authors except LS served as informants for the study. This arrangement raises the possibility that informants, as the ethnographer's employers and co-authors, can restrict what she reports (Hess, 2007). Cognizant of this possibility, all co-authors' contributions to this report were made after the first draft was completed and with an effort not to constrain its content and analytic scope.

Obtaining institutional approval: “lots and lots of politics”

In the process of procuring funds to install and study the kiosk in the EDs, RG and JS called on an existing social and professional network in order to recruit new host sites for the project. In addition to the home site, physician colleagues (one staff physician and two directors of research) at three California hospitals were enlisted as local “champions” of the kiosk study. Following the “diffusion of innovations” theory's concept of a champion as an influential person who can promote or counteract resistance to a newly adopted “innovation”, these local collaborators were

expected to help gain institutional approval for the kiosk and encourage its use at their respective sites (Aagaard et al., 2010; Rogers, 2003). In return, they would have the opportunity to participate as co-authors on publications, and retain use of the kiosk and UTI program indefinitely. Champions were also encouraged to submit ideas for additional modules that would enhance the usefulness of the kiosk at their site. Research funds were provided to each study site to help cover participation costs.

Clinical and administrative approval for the kiosk was obtained relatively quickly at three of the four hospitals. At East Hospital, however, the project encountered difficulties from the outset. The lead researcher at the hospital expressed support for the kiosk and urged its approval for use in the ED. Several ED managers and staff members, however, expressed concern that the kiosk might not be easily integrated into existing ED work processes. Questions they felt were not adequately addressed by the implementation plan included: Where will the kiosk be placed? How will the privacy of patients be assured? Who will refer women to the kiosk? What will the role of triage nurses be? As we explain below, similar questions were relevant at all four sites, but only at East Hospital were they initially thought to present a significant barrier to adopting the kiosk.

Resistance to the kiosk at East Hospital also resulted from a perception that the UTI program would offer faster services to some patients at the expense of longer wait times for others, since there was a possibility that staff time would be diverted to patients offered “expedited” service by the kiosk. At this urban safety net hospital with a long history of serving a high proportion of low-income, uninsured and publically insured patients, fairness and equity were key institutional values thought to be instantiated in the practice of triage. Staff at East Hospital feared that a project requiring changes to the triage process – particularly directed by researchers from outside the hospital – would undermine the institution’s ethos of equitable patient care and threaten its professional autonomy. In the words of a research staff member:

It was hard to get management to do the UTI module because of ethical reasons...if you have a UTI it’s hard to push you up [the queue] versus somebody that’s homeless that has a broken arm or something like that. Because we deal with a vulnerable population...

At that time, management was also trying to work on ED flow. So if this module decreases ED wait time considerably then somebody from [outside the hospital] gets all the credit... Interviewer: So they would like the solution to come from within? Right... Lots and lots of politics.

In short, at East Hospital the kiosk was unable to perform as the simple time saving tool that it was designed to be because the interests of hospital staff came into conflict with the kiosk’s prescribed ordering of tasks. This means that although the kiosk offered the promise of moving patients more quickly through the ED, it also threatened existing institutional practices and identity by shifting one aspect of triage decision-making away from staff. Without a thorough understanding of these dynamics, the research team interpreted the hospital’s concerns about the kiosk as irrational. Despite continued efforts to promote the kiosk, the device continued to serve as a lightning rod for institutional politics, particularly contested definitions of good patient care and economies of professional credit. The controversy was ultimately resolved by the hospital ED’s decision not to adopt the UTI program.

Positioning the kiosk: an unwieldy device

At the urgent care clinic where the UTI program was developed, referring patients to the kiosk was relatively straightforward. The

clinic operates on a same day appointment basis, and for the most part patients receive services in the order that they arrive. Women reporting UTI symptoms on check-in were offered the kiosk as an alternative to waiting for a clinician. If any of the answers entered on the touch screen indicated a potential complication, the kiosk indicated that the patient should return to the registration desk to wait for an appointment with a clinician. If a patient completed the module and was found eligible for “expedited” treatment, the kiosk would print out a summary of her answers and a treatment recommendation. Front desk staff would place the print-out in the “next-to-be-seen” box, and a clinician would then call her back to a private triage or exam room, quickly review her medical history on the print-out, select one of several recommended antibiotic treatment regimens, and hand the prescription to her.

In EDs, however, situating the kiosk – spatially, socially, and clinically – turned out to be a considerably more complex task. In most EDs, registration and waiting areas are separated from areas where triage and medical examinations and procedures are performed. Moreover, walk-in patients typically pass through two phases of triage – the first a rapid, provisional assessment by a triage nurse at the registration desk. Patients not requiring immediate medical attention pass through a second stage of triage after a variable wait time, usually in an area adjacent to registration and separated from the waiting room by locked doors. Researchers asked triage nurses to refer patients to the kiosk immediately after check-in, but in practice patients were often sent to the kiosk during the second stage of triage. Ideally, the kiosk would be positioned close to the registration desk and waiting areas, while still offering privacy to patients and accessibility to nurses conducting triage. This balance was difficult to achieve in a crowded, busy ED, and at some sites the kiosk was moved repeatedly from the public waiting area to a triage room and then back again in a search for a better location.

Positioning the kiosk was also made difficult by the device’s ambiguous status as a clinical-diagnostic tool designed to be used in spaces not typically designated for medical service delivery. In the waiting room, for example, the kiosk could operate as a medical device, but its more “public” qualities also came to the fore – i.e. it was more prone to vandalism, eavesdropping and unwanted uses. Spaces designated for triage, on the other hand, are typically small and crowded with furniture and medical devices. The kiosk’s role as a clinical device was more secure in these areas, but it was less accessible to patients and more easily overlooked by nurses already in the process of conducting triage. In both locations, patients reported concerns about a lack of privacy. As an ED physician concluded, “I don’t think we ever found the exact right place.”

The kiosks also exhibited intermittent mechanical and electronic breakdowns. In a busy ED with only one kiosk, a jammed printer interferes with the time-sensitive work of triage, in which hesitation or delay can have dire consequences. A device that has been integrated into ED clinical practices may be forgiven the occasional need for repair, but the kiosk never achieved this status. Rather, mechanical and electronic failures exacerbated nurses’ and physicians’ eroding confidence in the device.

Referring patients to the kiosk: “a simple change”

The kiosk was not designed to attract or recruit patients because its developers assumed that staff would refer appropriate patients to it, and that these referrals would be more or less automatic. In other words, the design/research team imagined that kiosk referral would be easily embedded in the complex sequence of tasks already performed by triage nurses. In practice, however, nurses did not refer patients to the kiosk as often as they had agreed to – particularly at County and Valley Hospitals.

The research team was puzzled by nurses' apparent reluctance to refer patients to the kiosk. Initially, triage nurses at all three sites had expressed support for the project. "We certainly got the buy-in that we wanted almost universally," said one investigator. He described kiosk referral as a "simple change" that should have been easy for nurses to make, suggesting that the benefits of the kiosk were built into the device and activated by the simple action of referring patients. This helps to explain why the research team's explanations of unexpectedly low and inconsistent referral rates focused primarily on what they perceived as nurses' resistance to practice change, and the inability of nurse champions to promote new practices among their staff – referred to as the "failure of leadership on the nursing side" by one researcher. Some researchers also characterized ED nurses as being more committed to patient care than research, reflecting a "culture of independence" and systemic differences between EDs and other clinical settings:

...[ED nurses have] very different perceptions and attitudes about whether or not part of their mission is to participate in new knowledge translation and quality improvement...when you do dissemination work and you start spreading this stuff out, it's going to fail at places that don't care or want to change their behavior.

Nurses and nurse managers who had been enlisted as kiosk champions, on the other hand, suggested that kiosk referral was not as straightforward as it had been portrayed. A nurse manager at Home Hospital, for example, said that it was "hard to promote something that will add more work for nurses." Rather than explore why a time-saving device seemed to be creating more work for staff, however, she and other site champions, in collaboration with the research team, devised strategies to increase kiosk referrals that focused on changing nurses' practices – or increasing "buy in", as they put it. This included email reminders and signs posted on the walls of nurses' stations, monetary incentives, gifts, and competitions. These efforts did not result in a sustained increase in referral rates at any of the sites. As a physician at County Hospital explained,

It just decays the moment there's not someone [nurse champion or research staff] around, and yet this is supposed to be this self-sustaining kiosk that just works...

The focus on changing nurses' behavior and "attitudes" did not accompany a close examination of how nurses' actual work practices were affected by the kiosk, or the process by which nurses and physicians made (tacit and explicit) decisions around kiosk use or non-use. Moreover, the research team may have underestimated nurses' agency and decision-making authority in the ED. As an ED physician explained,

In emergency medicine, doctors are particularly beholden to nurses, as opposed to other kinds of places like the operating room, where traditionally doctors kind of are the bosses. ...we're more of a team place...so the nurses really kind of run the show.

Triage nurses' high status in the ED, combined with a lack of serious consequences for *not* using the kiosk, led to their feeling free to use or ignore the kiosk – except, to some extent, for nurses at Home Hospital, which is discussed below. This was particularly true after the project "lost momentum," in the words of one nurse. The prototype kiosk's original site, by contrast, was a physician-led practice where referrals were made by clerical staff at the front desk rather than by nurses. Clinic protocol required front desk staff to refer all women with suspected UTIs to the kiosk. Differing professional hierarchies and work dynamics may therefore help explain why referral rates were higher at the urgent care clinic than

at the EDs. To better explain nurses' reluctance to refer patients to the kiosk, we now turn to a discussion of the device's "internal" decision-making program, or algorithm, whose purported ability to produce "expedited" care became unstable and contested in the context of ED medicine.

(In)eligibility for kiosk-assisted care: waiting for a "golden ticket"

In the EDs, an unexpectedly low proportion of referred patients were found eligible for kiosk-assisted care (6–30% across all sites during the study, whereas eligibility was consistently 40–50% at the urgent care clinic). Moreover, half of the patients found eligible were randomly assigned to a no-treatment control group as dictated by the study design – further reducing the proportion of women sent to the kiosk who actually received kiosk-assisted care. The computer program determined eligibility based on how patients answered multiple-choice questions about symptom duration and severity. A woman who reported symptoms such as painful urination for more than seven days, for example, was considered to be at higher risk of a kidney infection or other complication and was therefore ineligible for kiosk-assisted care.

ED staff offered several explanations for low eligibility rates. People visiting an ED may exaggerate their symptoms in the hopes of being seen faster. ED patient populations also tend to be sicker, with more "co-morbidities", than people seeking same-day appointments at urgent care clinics. This may be even more likely at public "safety net" hospitals such as Valley Hospital, which serves a population with overall poorer health and higher rates of chronic conditions like asthma and diabetes than the state average (Tu et al., 2009). Additionally, nearly half of all patients at the hospital are uninsured or publicly insured, and a large proportion are undocumented migrants from Latin America, whose fear of deportation may lead them to avoid hospitals except in dire circumstances. "Our patients are really sick...we rarely have any straightforward case in the ER" a doctor at Valley Hospital said, suggesting that identifying a patient who fits the kiosk's criteria for an uncomplicated UTI may be particularly unlikely in this setting.

Although we do not know with certainty why patients who were sent to the kiosk in an ED tended to report more severe symptoms than those at the urgent care clinic, it is clear that low rates of eligibility for computer-assisted care, and a study design that diverted half of eligible women to a no-treatment control group, contributed to triage nurses' increasingly negative perception of the kiosk. As a research coordinator explained, "That sort of thing can turn one nurse who was pro-kiosk to, you know, ambivalent about it." In part, this "turn" was the result of a contrast between how the research/design team initially described the kiosk and how the device actually performed. "We wanted to bill it as something to improve the quality of care that they provide to their patients," said a researcher when describing how they introduced the kiosk to ED staff. But this improvement was not forthcoming, reported triage nurses. At all three sites, nurses complained that high rates of ineligibility meant that the kiosk was not performing as promised. "The kiosk is supposed to be easy and reduce wait time, like at the airport," said one nurse at Valley Hospital, "but everyone we sent to the kiosk was ineligible!" Eligibility was referred to as a "winning lottery ticket" – a rare and seemingly random event that for many nurses was not worth the effort required to get patients to the kiosk.

The design/research team seems to have been aware that low eligibility rates were undermining kiosk "buy in" among nurses, but the team's efforts to address eligibility in the second year of the study did not include an investigation into nurses' perceptions or practices, nor did the team enlist nurses as collaborators when they

revised the computer algorithm. It appears that the designer-researchers hoped the new program – with “expanded eligibility criteria” designed to increase the proportion of patients found eligible for kiosk-assisted care – would increase study enrollment regardless of nurses’ referral practices. The new software led to a 20% increase in eligibility across the study sites, but referrals did not change significantly.

The new algorithm failed to draw most triage nurses into the kiosk network, and triage nurses’ description of the kiosk as a “detour” points to contrasting perspectives on the device’s effectiveness. For the research team and hospital management, even a small proportion of kiosk-assisted patients provided further evidence of the device’s ability to produce more efficient services, cost savings, and better patient care. From the nurses’ perspective, sending a patient back to the waiting room to complete the kiosk UTI program changed the order of standard triage practices, and demanded effort to keep track of the patient, including answering questions or troubleshooting mechanical problems, regardless of whether or not she received computer-assisted care. “It takes time, which you don’t have in the ER,” said a nurse at Home Hospital. In other words, eligibility rates were of concern to researchers and hospital administrators mainly as a type of clinical “output”, but for nurses the production of ineligible patients did not act as a mere absence or a signal to return to routine practice. Rather, low output actually disrupted the pragmatic work of triage, which illustrates how technology operates as an *active* participant in medical work even when it appears to be passive or dormant (Cresswell et al., 2010).

In addition, ED workers were often not convinced that being “expedited” by the kiosk actually resulted in faster, or more efficient, care. According to the kiosk study’s findings, women with suspected UTIs who received kiosk-assisted services had a median visit duration of 89 min, compared with 146 min among patients with suspected UTIs receiving usual care (Stein et al., 2011). Notably, however, this measured reduction in wait time did not account for ED staff efforts to manage the kiosk and its users, including both eligible *and* ineligible patients. As a physician at County Hospital explained,

...you have to grab a provider to actually fill out a quick chart and write a prescription, even though it’s all kind of spoon fed to them...there’s so many steps, and even when you get into the potentially fastest part of the algorithm, it’s still kind of slow.

A nurse summed up staff perceptions: “It would be better if you could say that it will expedite a patient’s care, but this just isn’t true.” Even when a patient was “fast-tracked” by the kiosk, she typically had to wait for a medical exam required by the Emergency Medical Treatment and Active Labor Act and usually performed by a physician or physician’s assistant. Moreover, treating a simple UTI “isn’t that difficult and doesn’t take that much time, so spending extra time to get people to the kiosk isn’t worth it,” said another nurse. Several nurses also expressed concern that the kiosk detracted staff attention from patients with life-threatening conditions. “UTIs are an urgent, not an emergent, problem,” said one nurse, applying the moral calculus of triage not only to UTIs, but to the kiosk itself – as a device that attends exclusively to patients whose medical condition may be treated more appropriately and cost-effectively in an urgent care or primary care setting. Thus, enrolling nurses in the kiosk’s network faltered in part because of a failure of “problematization”, i.e. many nurses did not agree on the definition of the problem that the kiosk was designed to solve.

The kiosk was also easy to “forget”, particularly since women with UTI symptoms arrived at the ED intermittently – sometimes as few as one or two per day. “The kiosk never crosses my mind,”

said a nurse at Home Hospital. At an institution like Valley Hospital, with about 200 ER nurses, it was even more difficult to maintain collective awareness of the kiosk. “There’s a parade of people who rotate through there over and over...every time you’d go out there and try to remind somebody, there was somebody who’d never heard of it,” said a physician-researcher. During a lull in ED activity, on the other hand, nurses felt that the kiosk was redundant. “When it’s slow,” explained a site research coordinator at Home Hospital, “I think that the nurse wants to just room the patient. They don’t want to send them back out into the waiting room.”

Resisting the kiosk, however, did not exclusively take the form of forgetting or neglecting to refer patients. A nurse at Home Hospital explained how she reframed the kiosk’s disruptiveness to her work routine by designating it as *only* a research project. She thought the kiosk did not function well as a proxy clinician, but she and other nurses continued to send women to the kiosk to support research efforts. Home Hospital’s large research program, and its ethos equating research with scientific progress, may help to explain why its ED stands out among the three kiosk sites: its nurses were critical of the project, but they consistently referred a higher proportion of patients to the kiosk.

The kiosk as virtual doctor: “we can’t program a machine to do it”

In the EDs, the kiosk’s usefulness was also contested on clinical grounds. Many clinicians did not want to forgo examining an “expedited” patient because, as one nurse put it, “they don’t want to miss the 1%,” referring to the possibility that a more serious medical condition may be present. A physician offered a similar logic for not entrusting the kiosk with diagnostic authority:

We’re trained to think the worst-case scenario on a patient. I never one time saw anybody that went through and had a printout [for computer-assisted care], but even if I did, I would still try not to let that corner me into thinking, ‘oh, this is a simple UTI.’

Whereas previous research had shown that the kiosk was as accurate or more accurate than clinicians at diagnosing uncomplicated UTIs among adult women, ED clinicians suggested that this effectiveness was diminished in an ED context. They attributed low eligibility rates to the kiosk’s inferiority as a virtual clinician, focusing particularly on diagnosis as a complex technical *and* social practice that cannot be reduced to a computer algorithm or otherwise decontextualized from the patient–clinician interaction. In the words of two physicians at Valley Hospital:

We can look at them and do our physical and then decide do we believe that that is kidney pain or is it something else? I think with the computer if you have a yes/no answer, then that’s the end of it.

I think that’s why we’ll always have jobs. ... the complexity of the decision-making – we don’t even understand how complex it is, so we can’t program a machine to do it because we don’t even know all the intangible things that we use.

When asked why the kiosk was more effective at the urgent care clinic, ED clinicians pointed to legal and institutional differences and socioeconomic variations in patient populations. For example, an ED operates under more stringent legal requirements to provide a clinical examination for every patient, they said. In addition, drop-in urgent care clinics’ patients tend to be middle class and to receive more regular medical care. At the kiosk’s home site, said an ER doctor, “a woman who comes in with a bladder infection knows she

has a bladder infection probably at least half the time, right? In an ED, other the other hand, “there’s never really one complaint.”

Conclusion

This case study of a promising, but ultimately unsuccessful, device serves as a cautionary tale for those seeking to promote IT projects in health care settings. The kiosk and its UTI algorithm were designed to function together as a “labor substitution” and “productivity” tool (Orlikowski & Iacono, 2001), performing tasks typically assigned to clinicians and improving clinical efficiency. According to the program’s designers, these capabilities were built into the device, i.e. it was expected to “work” and to work the same way at different sites. In the complex social milieu of emergency medicine, however, the kiosk enacted contradictory principles. On the one hand, it moved some patients more quickly through the ED by providing accurate, rapid diagnostic and treatment recommendations. On the other hand, the kiosk’s material and representational properties – and the study designed to test its effectiveness – engaged with triage practices in a disruptive way, making it difficult for patients and staff to benefit from the device. Thus, because the interests of crucial groups of ED actors failed to be aligned, the kiosk-as-network could not be adequately extended – or translated – to its new environment.

Notably, the way the kiosk’s designers imagined triage and diagnostic work, and later represented these processes in its software program, was more standardized and formal than actual ED work itself, which is always flexible and contingent on a moving constellation of clinical and social factors. Shifting between the requirements of the kiosk and those of actual triage and diagnosis required clinicians to “articulate the inflexible demands of technology to the practical requirements of the ongoing work” (Berg, 1998). This articulation broke down when triage nurses and other clinicians rejected the prescribed set of behaviors that was written into the kiosk for them. This process of “de-inscription” (Akrich & Latour, 1994), in which ED staff undermined or ignored the kiosk, reflect the degree to which the device was dependent on a continually re-enacted alliance among multiple actors – including ED staff, patients, researchers, and the device’s own hardware and software.

The key role of triage nurses in the story of the kiosk must be emphasized. Although nurses were not represented on the research team, it was clear that they were the primary link (and barrier) between patients and the kiosk and key actors in the destabilization of the device’s value when it was introduced in a new context. In emergency medicine, nurses operate as individuals and as members of collaborative work groups and a broader profession whose status in biomedical hierarchies continues to shift. Moreover, nurses have had a long, ambivalent relationship with technology that is entangled with their relationship with doctors. Technology has offered the nursing profession both the greater prestige of aligning with science and “progress” and an increased association with the “dehumanizing” tendencies of contemporary biomedicine (Sandelowski, 2000). In this case, triage nurses’ resistance to the kiosk on both pragmatic and ethical grounds can be understood as another brief chapter in this ambivalent history. Collaboration with nurses and patients in the design and re-design of the kiosk, in addition to a sustained, on-the-ground investigation of the social interactions and ethos of patient care in which kiosk (non)use was entangled, might have resulted in an entirely different kiosk – if a kiosk at all.

Designing complex health IT projects requires an in-depth understanding of the people and work routines to be affected, including institutional structures and values, worker–management relations, patient populations, professional identities, and other

factors that may facilitate or hinder sustainable adoption. It also requires an understanding that technology is only made effective and meaningful through use (or non-use), and through its position in heterogeneous assemblies of humans, other objects, and physical environments. This includes an acknowledgment that success and failure are socially negotiated – and often contested – categories (Berg, 2001). In the case of the kiosk, the researchers considered the study a success, and they published a report suggesting that the kiosk “accurately, efficiently, and safely expedited the management of women with uncomplicated UTI in a busy, urban ED” (Stein et al., 2011). ED staff, on the other hand, generally considered the kiosk to be a failure, and their “triage” of the kiosk resulted in the device’s being “unplugged” at all but the home site by the end of the study. However, competing conceptions of evidence for the device’s (in) effectiveness were not a subject of discussion or negotiation during the study, and ED staff perspectives were marginalized even when it became clear that most of the kiosks would be abandoned. Ultimately, even though it did not consistently fulfill its promise of expediting services, the kiosk became a political touchstone, a detour from routine, a contested mediator between the interests of research and practice, and a cumbersome object.

Unfortunately, many health IT projects are planned as if “implementation” were merely a matter of integrating technology into existing practices, and as if technological devices and systems operated as rational tools or “evidence” machines – containing and reproducing stable “facts” about the world (Goldenberg, 2006). This approach imagines technologies, hospitals, medical workers, and patients to be “pre-givens, thus making the critical task the creation of a ‘fit’ between technology and organization” (Langstrup, 2008). A sociotechnical approach, on the other hand, presumes that humans and technologies are always co-constituted as they interact and that “evidence” is not always stable as it moves from one setting to another. New technologies can change work routines, professional identities, and understandings of appropriate patient care, and workers themselves may resist or use technologies in unexpected ways. Although debates about the meaning and definition of actor–network theory continue to unfold (Law & Hassard, 1999), its insights offer a largely untapped resource in the expanding arena of health IT. We hope that this report helps to persuade IT developers of the usefulness of drawing on sociotechnical theory and ethnographic methods in the design, implementation and evaluation phases of their projects.

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