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UNIVERSITY OF CALIFORNIA,  
IRVINE

Learning from Users' Adaptation Experience:  
Outlining the Design Space for Health IT Systems

DISSERTATION

submitted in partial satisfaction of the requirements  
for the degree of

DOCTOR OF PHILOSOPHY

in Information and Computer Sciences

by

Sun Young Park

Dissertation Committee:  
Associate Professor Yunan Chen, Chair  
Professor Bonnie Nardi  
Professor Judith Olson  
Professor Gloria Mark

2015

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# DEDICATION

To  
my family



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# CURRICULUM VITAE

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# **ABSTRACT OF THE DISSERTATION**

Learning from Users' Adaptation Experience:  
Outlining the Design Space for Health IT Systems

By

Sun Young Park

Doctor of Philosophy in Information and Computer Sciences

University of California, Irvine, 2015

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No IT system is perfect at the time of its deployment. Users gradually adapt to the technology through everyday use. This is especially true for IT systems that are situated in complex environments, such as the healthcare domain. In a typical medical environment, information is constantly changing, and patient care tasks often require close collaboration among multiple providers and care teams. These challenges escalate the difficulties of designing effective health IT systems. They also makes users' technological adaptation behaviors a particularly important research area as adaptation behaviors directly inform the (re)design of such systems. This dissertation investigates users' adaptation behaviors and the subsequent redesign practice in an in-depth ethnographic study of an implementation of a hospital-wide Electronic Health Records (EHR) system.

I conducted two case studies in an Emergency Department (ED) affiliated with a large teaching hospital. The first study evaluates ways in which healthcare providers engaged in the adaptation process after a large-scale health IT system deployment; the second study examines the ways in which patients engaged in adaptive behaviors in this sociotechnical environment to leverage information breakdowns and ensure their quality of care. Qualitative and ethnographic formative research methods were used to examine both the providers and the patients' information practices. The results of these studies indicate detailed adaptation processes. They shed light on how a newly deployed health IT system alters clinical work practices; how individual clinicians and a healthcare organization respond to a new system through technological and organizational adaptations; and how patients engage in various adaptive behaviors to achieve quality of care when information and technologies are not available and/or do not meet their needs.

Based on the study's findings, I argue that the adaptation practices from these two different stakeholders are active end-user driven design practices, with significantly common characteristics. My study further reveals that these adaptation practices comprise two types of adaptive goals – one addressing immediate breakdowns and the other addressing healthcare specific needs – both of which are undervalued, yet crucial parts of healthcare organizations. This study provides broader design implications for evaluating and designing a sociotechnical information system in highly-regulated, complex, and information-critical contexts, focusing on the role of HCI researchers and designers.

## CHAPTER I.

# INTRODUCTION

Although system designers tend to envision their carefully designed systems as being immediately usable after deployment, previous studies have found that it is often difficult for systems to work in their designed use because of the unique configuration of every socio-technical context (Leonard 2011; Orlikowski and Hofman 1997; Tyre and Orlikowski 1994). Because of this, users are often forced to change their behaviors and workflow, or sometimes bypass certain functions of technology. This is referred to as *technological adaptation*. The adaptation period is considered crucial in system deployment as there is no such thing as an impeccable system and it usually takes time for users to learn and adapt to the new technology. Adaptation has been defined as the process intended to modify the new technology or relevant aspects of the operating context, including users' skills or procedures (Tyre and Orlikowski 1994). In studying the technology adaptation period, many prior studies have developed different adaptation models for describing the relationship between the technology and its users; some have focused on the adaptation patterns of user behaviors (N. Boulus and Bjorn 2010; Convertino, Moran, and Smith 2007; Grudin and Palen 1997), while others have studied how users have modified the technologies (Leonard 2011; Orlikowski and Hofman 1997; Tyre and Orlikowski 1994; Zhou, Ackerman, and Zheng 2011).

In the healthcare domain, where this current study was conducted, the use of large-scale complex information systems, like the Electronic Health Records (EHR), is often considered unsuccessful, despite huge investments of time and finances. Industry experts in the U.S. estimate that EHR implementation failure rates range from 50-80% (“Healthcare Informatics Magazine” 2008). Similarly, the Physician Workflow study (Jamoom and others 2012) found that 54% of physicians had adopted an EHR system; among the physicians who had adopted an EHR system, fewer than half reported being somewhat (47%) or very (38%) satisfied with their system . A number of studies on EHR implementation have reported unintended consequences on clinical practices after system deployment, such as increased documentation time (Cyert and March 1992; Poissant et al. 2005), system induced medical errors (J. S Ash, Berg, and Coiera 2004; Koppel et al. 2005), more interruptions to clinical workflows (Richardson and Ash 2008) and workflow incompatibilities (Cyert and March 1992). Some recent studies also examine the impacts of the EHR system use on patients during clinical consultations, and have found that while both clinicians and patients agree that the EHR is indispensable as a mean of record keeping and sharing, patients perceive it as an interference since it take the physician’s attention away during clinical encounters (Park and Chen 2012; Ventres et al. 2006; Zhang et al. 2015). As such, having a successful design and deployment of health IT is a daunting task in clinical practices.

In addition to clinical health ITs, interests in developing systems for patients, another critical stakeholder and the counterpart of healthcare providers, have been recently increasing. Many Human-Computer Interaction (HCI) and Medical Informatics studies have examined patients’ access, use, and management of health-related information through technologies, such

as online patient portals and mobile health applications; these studies discuss various benefits such as an increase in patient awareness of health, better patient engagement in the treatment process, and improved health outcomes (Bloom 2002; Wilcox, Feiner, and Vawdrey 2014; Prey et al. 2014). Nevertheless, compared to the significant progress made in patient information use in domestic settings and before/after clinical visits, few studies have recognized the need for designing health IT to provide information access to patients during their ongoing care, such as in hospital stays or emergency visits. The few case studies that have been conducted include examining the patient information needs of knowing a medication list in a cardiology inpatient unit (Wilcox et al. 2012), designing a virtual nursing agent providing discharge instructions to patients in an inpatient unit (Bickmore, Pfeifer, and Jack 2009), and exploring a mobile device use that provides care process information in an ER (Pfeifer Vardoulakis et al. 2012). Designing health ITs for patients is a very recent effort, and these researchers have not yet further studied the details of patients' current information work practices, such as when and what information patients need during their hospital stays, how they cope with information breakdowns, and how they perceive and adapt to technology use, as well as their care situations. More research is required on the impacts and adaptation of health IT systems for patients.

So why is it so difficult to design and deploy these IT systems in the healthcare context?

In general, designing systems to fit into such complex healthcare environments is extremely difficult, since designers often have limited knowledge about clinical medicine and the work practices of healthcare – how clinicians work in complex clinical environments, how patients manage their illnesses, and the interplay between these two stakeholders. Thus, it is impossible

to create systems perfectly matched to the healthcare setting, and the design often needs to be adapted by users to fit with their work practices.

The slow adoption/adaptation of health IT systems occurs for the same multitude of reasons that cause the health IT system design challenges. First, it is particularly onerous to design a perfect information technology system for the healthcare environment because the system needs to address the complex nature of patient care, as well as embrace different stakeholders with unique goals and needs. Second, successful system design requires not just the technological aspects involved, but also an in-depth understanding of the human processes underlying the design, which can often be overlooked. In particular, with regard to the EHR, research shows that system use and adoption is largely related to user satisfaction, rather than to specific features or to the overall efficacy of the system (Igharia, Iivari, and Maragahh 1995; Lee et al. 1996). Third, the design, as well as the deployment of a large-scale, comprehensive system in an organization, needs to support that organization's complex relationships. A necessary technology adaptation period for users-in-practice frequently occurs when the system design imposes the centralization of information and the standardization of a workflow that does not properly match or support the unique goals, tools, workflows, and cultures of the heterogeneous departments across the organization. Thus, researchers now recognize the significance of cultural, behavioral, and organizational factors, and the importance of taking these factors into account to achieve better system design, user acceptance, and adoption for large-scale health IT (Brender et al. 2006; Kaplan et al. 2001; Lorenzi et al. 1997; Southon, Sauer, and Dampney 1997).

Based on the challenges in the design and the use of health IT, studies have shown that adaptation is critical to bridging the fit between design and actual use (Barley 1986; Nina Boulus 2009; Zhou, Ackerman, and Zheng 2011) Both the Medical Informatics and HCI communities have examined technological adaptation in the healthcare settings. Many have studied the impacts of information systems, not only on people's behaviors at the individual level, but also on the organization of work practices conducted in the healthcare institution (Embi et al. 2004; Fitzpatrick 2004; Novak et al. 2013); some have presented both the beneficial and the detrimental effects of health IT through evaluating individual behavior changes or workaround use (Gagnon et al. 2003; Zhou, Ackerman, and Zheng 2011) However, this prior approach does not explore how users are involved in the adaptation process, or how the adaptation process might inform design practices, something that needs to be looked at, given the importance of technology use in the healthcare field and the significant consequences these systems may have. In addition, while the majority of system adaptation research focuses on adaptation behaviors made either by individual users or by one type of user (healthcare providers, in particular), less is known about how organizations respond to the impact of these new technologies, or how other types of users, such as different stakeholders (e.g., patients and caregivers), are affected by the impacts of the new technology use and what adaptation behaviors they may engage in, in efforts to adapt to the new sociotechnical environment.

Therefore, to fill this gap, my dissertation research investigates users' adaptation behaviors through a newly deployed EHR system implementation, the key information infrastructure system that diverse users rely on in a healthcare organization setting. I illustrate this through two studies: the first evaluates and tries to understand how a large-scale



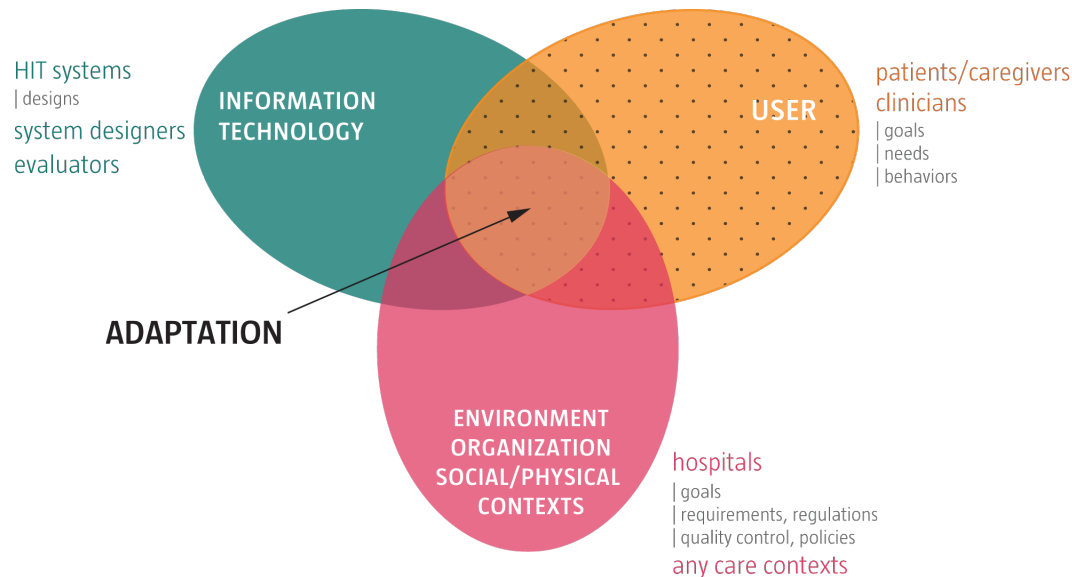
sociotechnical system is adapted by a complex clinical environment, and how healthcare providers engage in this adaptation process; the second examines ways in which patients engage in adaptive behaviors in this sociotechnical environment during their ED stay. In this thesis, I aim to draw lessons from the system adaptation to benefit the design of future health IT systems, clinical work practices, and the patient care environment.

## Research Approach

I situated this study in the field of healthcare for several reasons. First, the complexity of healthcare provides much research value. The critical, but complex aspects of healthcare work practice have been well noted in the HCI community, such as temporality (Reddy and Dourish 2002), spatiality (Bardram and Bossen 2005), workflows (Chen 2010), and communication breakdowns (Reddy and Dourish 2002). Second, many of the deployed systems in this field have failed in successful adoption and adaptation, despite enormous time and financial investment, as seen above. Third, it is impossible to design a perfect system that can address multiple users' (such as patients) needs as well as those of an organization's. Especially now that health IT systems are expected to be broad enough to meet needs across different organizations nation-wide, the need for understanding adaptation practices is more significant.

In this thesis, an ethnographic evaluation study of a health IT system, I have found that adaptation is, in fact, situated in the interaction of the user, the system, and the environment/context/organization (Figure 1.1). What I mean, specifically, by these three elements is that the **user** can be a patient, caregiver or clinician; the **environment** refers to hospitals or any other care context; and the **technology**, in this case, would consist of health IT

systems, such as EHRs. Each of these elements has unique goals and needs – for instance, a hospital has certain rules and requirements for quality control. As the diagram indicates, the three key elements are all interrelated, and all three must interact with one another.



**Figure 1.1** My research approach framework: user, information technology, and environment

In this approach, what I aim to examine is the intersection of these three elements, where users engage in information activities when accessing and using information technology in care contexts. More importantly, I view this information work practice, which is the intersection of the three spaces, as a **users' adaptation**. This adaptation is the process through which users adjust to new technology, as well as the environment where users participate in the care process. Specifically, for instance, when clinicians use a new technology, such as a newly deployed EHR system, clinicians may need to change their own work process. They may also need to change their work environment, by changing the physical layout of their workspace in order to make their workflow more efficient; or they may need to change the technology itself,

e.g. skipping certain buttons or pages in the medication order section of the EHR in order to work faster. Thus, a new practice emerges when these three elements all meet, interact, and work together. This new, emerging practice can be seen as a users' adaptation practice, a concept which will be elaborated on in detail throughout my dissertation.

This dissertation's analysis of the adaptation process reveals a user-driven design process that plays an important role in the implementation of large-scale, complex health IT systems. I describe how these systems are adopted by clinicians and adapted in a complex healthcare setting. More importantly, I discover a rich picture of clinicians' active reinterpretations and modifications of their work practices through their engagement with the system-in-use and its organizational and physical contexts, as well as how patients' proactive coping mechanisms are used to adapt to the socio-technical environment. I conduct an in-depth exploration of the impact of the new system deployment and the challenges which arise during use, uncovering the tactics used by different stakeholders (clinicians and patients) to address these challenges and reveal key adaptation characteristics caused by domain-specific problems reflecting the unique requirements and policies characterizing the healthcare setting.

## **Research Goals and Questions**

Researchers across the HCI, CSCW, and Medical Informatics communities have long recognized the significance of clinicians' technological adaptation for clinical work practices, by identifying its benefits, as well as its unintended consequences. Building on these works, I assert that – (i) users' adaptations take place not only to adapt to the newly deployed system, but also to the new environment, and (ii) the design and use of health IT systems affect not only its

primary users, but also its secondary users within the same care environment, i.e. patients and caregivers. I outline how different stakeholders adapt to the new technology, and to the socio-technical environment as a whole. I argue that the highly reliable healthcare organization acts to address the system's unintended consequences in this adaptation process.

Most evaluations, to date, have been limited in time and scope (e.g., (Chaudhry et al. 2006; Lorenzi et al. 1997)), as the evaluation of large-scale health IT system can be a complicated endeavor. For example, many evaluations have been post-hoc, conducted mostly through retrospective surveys after the systems were implemented (Joan S. Ash et al. 2005; Joan S. Ash et al. 2007; J. S Ash, Berg, and Coiera 2004; Callen, Westbrook, and Braithwaite 2006; Garrido et al. 2005; Harrison, Koppel, and Bar-Lev 2007), and have mainly focused on the impacts on and behaviors of the primary stakeholders. In contrast, this dissertation project grew out of a unique opportunity to conduct a comprehensive evaluation of the implementation of a large-scale health information system, including evaluations throughout the baseline (pre-deployment), roll-out, and post-implementation stages. This approach provides a clearer view of the nuanced and situated changes involved in the user adaptation process, and offers insights into the effects of the system deployment during the transition period. My study also explored how the different types of end-users adapt to the sociotechnical context as a way to better access and use information, when the system was not necessarily designed for them. This offers valuable insights for design guidelines for the health IT systems that are required to serve a variety of the needs and goals of stakeholders in such complex settings.

The purpose of this dissertation is to describe and understand adaptation practices – how clinicians adapted to health IT systems, as well as how patients and caregivers adjusted to the care environment – in order to provide empirical guidance and design implications for future health IT systems in hospital settings. I have found it important to include multiple actors; despite their unique needs, goals and cultures, all the actors in this study are greatly influenced by the information system’s design and the system environment, including the physical and social context, as well as organization in which they all participate in the healthcare process. The insights thus gained enable me to understand, evaluate, and design healthcare information technologies and adaptation practices from multiple angles, including both providers and consumers, and the possible interactions between them. My research was informed by the following list of questions pertaining to health IT system use and adaptation.

*For clinicians’ practice:*

- How does the health IT system impact clinicians’ work practices?
- How is the health IT adapted to the complex clinical work environment?
- How are clinicians, as well as the organization, involved in the adaptation process?
- What can we learn from the system adaptation to benefit the designs of such systems?

*For patients’ practice:*

- What are the information needs and breakdowns patients encounter during their care process?

- What are the patients' behaviors when seeking and obtaining information, or coping with breakdowns, in adapting to this complex care environment?
- What design opportunities can we develop for health IT to address the challenges and breakdowns patients face in order to support patient needs and behaviors?

For this dissertation, I conducted two formative studies in an Emergency Department (ED) at a large teaching hospital. First, I studied the ways in which clinicians responded to a newly implemented EHR system to make it better fit into their work practices. Second, I investigated how patients adapted their behaviors in a complex, information-rich care context during their ED stay to meet their basic information needs and cope with information breakdowns. My findings suggest that both clinicians and patients actively engage in adaptation practices in order to adapt to their own sociotechnical environments; my findings also indicate that adaptation is, in fact, the active end-user driven design practice emerging between users, the new system, and the environment/context/organization.

My research approach is grounded in the qualitative and ethnographic formative research methods (*in situ* field observation, shadowing interviews, contextual inquiries). Ethnographic fieldwork helps capture people's needs, behaviors, and work and cultural practices situated in real-contexts that are in a state of continuous change, so I deployed extensive qualitative approaches to investigate in-situ information work among healthcare providers/consumers. I translate these results into implications for design opportunities and system implementation guidelines for future system infrastructure in such complex healthcare settings.

This work contributes to a larger research agenda: understanding large-scale sociotechnical system adaptations in workplaces. The asymmetry experienced by healthcare consumers and providers in the hospital context in terms of their respective access to information systems and how this can also apply to similar environments where diverse users have disparate information access and systems, yet must rely heavily on information or on other actors who have information access. Thus, this work can be a starting-point for researching barriers to designing and implementing sociotechnical systems that are used by multiple stakeholders in highly regulated, complex, and dynamic environments in general.

## **Thesis Overview**

This thesis is divided into six chapters, as follows.

Chapter Two describes related works about the development and implementation of information technologies in the healthcare domain. I describe how information technologies have been developed and used, not only for clinical work practices but also for patient care practices. I then explain the research gap, the relevance to my work, and how my current work addresses the gap.

Chapter Three presents an overview of the formative studies I conducted, focusing on the methodology used. I introduce my research field site, ED work practice, and my study population. I then outline the methods used to collect and analyze the data from the field.

The findings of this work are presented in Chapters Four and Five. Chapter Four describes the results of my evaluation study on EHR implementation. It details the ED clinicians' adaptation process at the individual and organizational level. I also describe design

implications for future sociotechnical system design and implementations in the domain of healthcare.

Chapter Five focuses on the findings regarding patient engagement in adapting to the sociotechnical environment during ED care. It presents the patients' adapting behaviors as a way of accessing and obtaining information in an environment without information system support and the coping mechanisms patients developed to overcome information breakdowns. The results presented in this chapter provide a different perspective from the previous chapter on adaptation in the same care environment. I then reflect on the assumptions made about the value of the underlying users and the overall healthcare practices surrounding the large-scale sociotechnical system, and provide design suggestions for incorporating patient-centric technology into hospitals.

Chapter Six reflects and draws conclusions about the implications of future health IT systems. I highlight the importance of adaptation as a design practice, and discuss two distinct forms of adaptation practices gleaned from the study. This chapter further synthesizes the challenges of, and guidelines and opportunities for, large-scale, complex sociotechnical information infrastructure systems in healthcare settings.



## **CHAPTER II.**

# **BACKGROUND AND RELATED WORK**

In this chapter, I review prior CSCW and HCI literature examining the healthcare practices and the health IT studies that address technological intervention and use, benefits and reverse affects, and challenges in clinical and patient practices. I also review studies on technology adaptation, and its theories and practices in other organizational settings. This is an attempt to identify gaps in the body of existing literature in understanding health IT development and user adaptation, and further elaborate on the research questions I am interested in investigating in this dissertation.

### **Prior CSCW and HCI Research in Healthcare Practices**

Healthcare practices have been of immense interest to the CSCW and HCI communities because compared to other domains, the work in healthcare is characterized as more dynamic, complex, and information-rich (Bardram and Bossen 2005; Bardram and Hansen 2010; Luff and Heath 1998). As such, much research has been conducted examining a variety of important aspects core to medical work, such as work coordination, work communication, and work collaboration in healthcare. These include temporal coordination (Bardram 2000; M. Reddy and Dourish 2002), shift cycles (Zerubavel 1979), artifact use (Xiao et al. 2001), redundancy and

interruptions (Cabitza et al. 2005; Tjora 2004), sense-making (M. C. Reddy, Dourish, and Pratt 2001), information sharing (C. Tang and Carpendale 2007), communication flow (M. Reddy and Dourish 2002; Tucker 2004) and workflows (Chen 2010). In addition, the use of information technologies and its impacts on clinical work have been frequently studied, including both the beneficial and detrimental impacts of computerized documentation on clinical and educational practices (Embi et al. 2004; B. Kaplan 1997; Zhou, Ackerman, and Zheng 2009).

The complexity of the healthcare field, in fact, has been widely noted by the HCI community. Previous research has exposed a variety of issues affecting the successful design and implementation of the health IT in medical workplaces, such as temporality in coordination (M. Reddy and Dourish 2002)spatiality in collaboration (Bardram and Bossen 2005), compatibility in workflows (Chen 2010),and breakdowns in communications (M. Reddy and Dourish 2002). This rich stream of research indicates the magnitude of the challenges in current healthcare system designs and calls for a more comprehensive work practice analysis in order to design systems for the complex medical work environment.

Besides clinical practices, prior CSCW and HCI studies have also examined patient care practices. With a significant increase in chronic illnesses, effective patient care practice has been emphasized by requiring patients' active participation in managing their own care. Many technologies, as well as a magnitude of information available online, support patient access to manage health-related information in various healthcare settings. The benefits of providing patients with access to their health information have been well-recognized across many studies. They include increased patient participation in decision-making about their care, reduced

conflicts in decision-making between providers and patients, and increased patients' adherence to care (S. H. Kaplan et al. 1995; Greenfield et al. 1988).

To date, most of prior studies on patient participation concern chronic illness management between outpatient and domestic contexts. This includes a recent research stream on personal health informatics, including health monitoring and tracking tools, that allow patients to make sense of metrics such as glucose levels, heart rate, step counts, and so on (Bloom 2002); it also includes the development of online health portals and Personal Health Records (PHRs) that provide patients with access to their complete medical records (P. C. Tang et al. 2006). Work in this area has helped foster patient access and participation in their own care process, by enabling patients to view their detailed medical reports and reflect on the progress of their care. However, these previous studies have not contributed enough to the care contexts of hospital stays or emergency visits, where patients still have unmet needs in terms of situational and real-time information access and support.

## **Health IT on Clinical and Patient Practices**

Health IT has been publicly touted as the key to enhancing efficiency in healthcare. A large-scale health IT system, such as an EHR, that often takes years to implement. Nationwide adoption of these systems in the United States is an imperative to better understand the adoption, adaptation, and design of EHRs. Prior studies have examined diverse impacts on clinical work processes introduced by electronic documentation. For example, the work of Embi et al. (Embi et al. 2004) identifies the fact that computerized documentation greatly enhances the

accessibility and legibility of medical notes; however, electronic documentation changes the workflow, alters the structure of the MD notes, and even introduces errors into the documenting process. There are other studies that have examined changes in the work process. Kaplan suggests that the way medical documents are “written, read and used” in electronic documentation systems has been largely overlooked (B. Kaplan 1997); Zhou et al. indicate the loss of important psychosocial information during the documentation process with deployment of the new CPOE system (Zhou et al. 2009); and Payne et. al present a new framework for a document’s life cycle based on when information is documented, who documents it, and how it is documented (Payne et al. 2006). In addition, various design guidelines have been proposed to improve the usability of EHR systems, ranging from interface-level modifications such as supporting handwritten notes in electronic format (Payne and Graham 2006), scanning and eliminating paper-based records for faster transition to full utilization of an EHR (La erum, Karlsen, and Faxvaag 2003), and improving alert functions (Piasecki et al. 2005), to broader-level changes, such as enhanced communication and education for both providers and consumers (Ash and Bates 2005). Nonetheless, how actual patient care and medical practices are affected by changes in the clinical documentation processes with the use of electronic systems remains unreported in these studies.

Previous studies indicate that the use of health IT benefit medical practices in various ways, including providing easy access to and accurate documentation of patients’ records (Bates et al. 2003; Hersh 1995; Zhou et al. 2011), reducing potential medical errors (Dykstra et al. 2009), standardizing practice (Mwanza 2002), improving the quality of patient care (Mwanza 2002), and billing management (Mwanza 2002; Poissant et al. 2005). However, these benefits are

often coupled with unintended consequences in the actual work practices, such as increased documentation time (Embi et al. 2004; Pratt et al. 2004a), incompatibility with clinical workflow (Embi et al. 2004), more interruptions in medical work (Rittel 1984) , and system-introduced errors in patients care (Ash et al. 2004; Hardey et al.2000). Based on such findings, these works have revealed the problems in current healthcare system designs and call for more comprehensive work practices analysis in order to design systems for the complex medical work environment, and indicated the importance of focusing on the possible impacts of documentation when studying health IT.

The use of new systems naturally leads to work practice changes in broader levels; one study argues that human, social, and organizational factors play crucial roles in the deployment and use of health IT systems (Aarts et al. 2010). Pratt et al. emphasize the importance of understanding of how individuals collaborate when designing and deploying medical information systems in computer supported cooperative work (CSCW) environments (Pratt et al. 2004b; C. Tang and Carpendale 2007). Other studies emphasize system implementation and its relationship to organizational change. For example, technologies were found to alter organizational structures in two case studies of the implementation of CT scanners in radiology departments (Barley 1986). In these case studies, the newly implemented CT scanners changed the institutionalized roles and the patterns of interaction among the radiologists and the radiology technicians in the departments. Technology deployments, such as the implementation of a patient care information system, are viewed as a process of mutual transformation between the organization and the technology rather than merely as a matter of bringing an automated tool into a working environment (Marc Berg 2001). The use of technology is deeply interrelated

with actions at the individual level, but also with interactions among individuals at the collaborative level and with social and organizational structures. However, although these organizational studies and design papers discuss various social impacts resulting from the use of healthcare IT systems, they rarely associate these impacts with the original system design and provide design guidelines to alleviate these impacts.

The crucial aspects of healthcare work practices, such as the temporal coordination of providers and mobile workflows, have been extensively examined in system designs, as seen above. However, health IT systems are designed mainly for improving work efficiency for providers, management and administrative work, and usually leave patients out of the picture. The impacts and consequences of the systems on patients have not really been considered yet. Since patients are not included in the current system designs, there may be far more unintended consequences – both social and other -- than previously reported. For example, my previous work (Park and Chen 2012) showed that despite its benefits, the EHR system caused ED doctors to become stationary in their charting room, resulting in patients having less physical interaction and communication time with their doctors. In addition, since the current health IT systems exclude patients from their design and do not provide patients any access to their information, this may lead to a decreased awareness and participation in their care, regardless of their wishes.

Although health IT has been under development for years, to date most of the current health IT systems focus primarily on clinical use; only very few studies have garnered direct attention to patients in a hospital setting – another important stakeholder in the clinical care setting. Only these few studies have examined how health IT systems can facilitate the access

and use of information during the patient care process in hospital settings. For instance, Wilcox et al. designed a tablet application to provide inpatient medication histories for patients in a cardiology unit, and found that it improved patient satisfaction and enhanced patient-provider communication (Wilcox et al. 2012). Vardoulakis et al. found that receiving information about care-progress information via mobile application reduced patient anxiety and enhanced patients' ownership of their medical information (Pfeifer Vardoulakis et al. 2012). A virtual nursing agent, a system that educated patients on their discharge instruction at bedsides, was designed by Bickmore et al. to explore impacts on improving patients' health literacy and empowerment (Bickmore et al. 2009). Yet, as agreed upon in these recent works, more research is needed to create innovations capable of delivering more information-rich, empowering experiences for patients during hospital stays or emergency visits. This shows an important need to consider and incorporate patients as another key stakeholder for future designs of health IT.

## **Theories and Practices in Adaptation**

The challenges of designing health IT systems lead clinicians to use various workarounds in order to cope with a new system's unintended consequences during adaptation (Armijo et al. 2009; Hersh 1995; Koppel et al. 2005; Leonard-Barton 1988). For example, nurses use workarounds, such as safety alert overrides and shortcuts to documentation, to minimize workflow disruption in electronic medication administration (Lee 1989). The workaround use in the medical context is often considered negative or unexpected consequences, since they may

bypass certain important safety rules (Lee 1989; Leonard-Barton 1988). Just like clinicians' workaround use, prior studies on health IT indicate that no matter how careful the systems are designed, users often have to take time for users to learn and adapt to the new technology (M. Berg 1999; Boulus 2009). Technology adaptation is defined as a process intended to modify the new technology or a related operating context, such as users' skills or procedures (Tyre and Orlikowski 1994). The adaptation process is considered a necessary stage after technological system rollout because it is extremely difficult to design a technology which perfectly fits the user environment immediately after deployment and users do not necessarily participate in the original design process (Leonard-Barton 1988).

Current literature provides multiple ways to conceptualize technology adaptation in organizations. The initial studies in technology adaptation treated technology as an independent factor that did not interact with the social context in which it was situated e.g. (Huber 1990); later studies began to view technology as part of a complex process where technology and social processes mutually influence each other over time (Grudin and Palen 1997; Barley 1986; Locke and Lowe 2007), and indicated how the technology participated in creating new practices and gradually transforming the work profession, instead of being just a tool (Boulus 2009)). In this latter view, some authors focused on the role of human agency in influencing technology in practices (Boudreau and Robey 2005; Orlikowski 2000; Latour 2004a). Recent studies suggest another perspective, where technology is part of a relational ontology where the social and the material are inherently inseparable and must be considered as whole in practices (Latour 2004b; Orlikowski and Scott 2008) or a process of imbrication (Leonardi 2011).



In addition to the various perspectives towards adaptations, past literature has also introduced various models that viewed adaptations: a discontinuous pattern after initially intensive adaptation activities (Tyre and Orlikowski 1994); a sporadic and ongoing process of altering existing conditions and structures of the group/organizational environments (Majchrzak et al. 2000); a constant fabrication of the system (Locke and Lowe 2007)]; a group knowledge sharing activity (Convertino et al. 2007); a mutual transformation between technology and its environment (Leonard-Barton 1988); and a routinization process (Goh et al. 2011). However, even though these prior studies provide different understandings and perspectives on the adaptation process, few researchers have looked at what motivates users to actively adapt to new systems, how individuals' adaptation behaviors might impact practices at the organizational level, and how such impacts are regulated and controlled in organizations. In particular, prior studies have seldom examined high-reliability domains like healthcare organizations, where strict organizational regulations and procedures are mandatory in comparison to user performances, which can be initiated at the individual level.

Technological adaptation has been recently studied in the healthcare domain since numerous health IT systems have been introduced and implemented, with hopes of improving efficiency, patient safety, accountability and billing (Hillestad et al. 2005; Wang et al. 2003). Many studies have examined technological systems that are deployed in clinical practices, such as EHR systems (Ash et al. 2004; Boulus 2009; Cyert et al. 1963; Hersh 1995); barcode medication administration systems (Koppel et al. 2008; Patterson et al. 2006); a computerized medication dispensing system (Azad and King 2008); and a computerized prescription order entry system (Zhou et al. 2011; Niazkhani et al. 2011). These health IT systems offer many benefits to

healthcare practices, including easy access to patient information and better administration of patient medication (Kaptelinin and Nardi 2006). However, failures or unintended consequences of using these systems have been frequently reported in prior literature. These include prolonged documentation time (Cyert et al. 1963; Poissant et al. 2005), increased interruptions (Richardson and Ash 2008), system induced medical error (Ash et al. 2004; Kobayashi et al. 2005), incompatibility with clinical workflow (Cyert, et al. 1963; Saleem et al. 2011), and even increased mortality rate (Han et al. 2005).

## **Gap in Prior Studies and Relevance to the Current Study**

Although system adaptation has been widely studied in health IT literature, less is known about the adaptation process in the fields of HCI and Medical Informatics from a holistic perspective. Previous technology adaptation studies in HCI and Medical Informatics have focused mostly on a conventional one-on-one (system to user) relationship, not mutually interactive relationships among these three factors over time. Aspects in need of further exploration include the mutual relations between different factors, such as users (including different stakeholders), large-scale information systems, and the information environment (context of use, physical environment, or organization) as it evolves over time. Particularly, in the field of healthcare, the environment factor could play a key role in the adaptation process due to the healthcare's distinctive characteristics and needs, which has not been well considered. Thus, in order to gain an in-depth understanding of adaptation practices, my study investigates the newly emerged adaptation practice through studying healthcare providers

adapting to the newly implemented EHR system in an emergency department as well as studying patients adapting to the ED care environment. Specifically, I describe how different stakeholders adapt to the new technology, as well as to the socio-technical environment as a whole, by describing two adaptation cases. The first case study is about healthcare providers' adaptation to their newly introduced system, and the other discovers how patients, who are imperative users but often overlooked, adapt to a new care environment immediately as they encounter it.

In this work, I address the needs of different sets of users who are required to adapt to their newly-deployed system or to a new environment they must contend with, particularly in the highly reliable and controlled healthcare field. Through this, I have aimed to unveil different forms of adaptation. Based on my examination of these situations, I specifically address the gaps and deficiencies in the design space surrounding this large-scale, complex health IT system implementation, by revealing adaptation as a user-driven design process. I also describe challenges and key adaptation characteristics caused by domain-specific problems reflecting the unique requirements and policies characterizing the healthcare setting.

## **CHAPTER III.**

# **STUDY OVERVIEW AND METHODS**

In this thesis, I study how users adapt to a socio-technical system and environment in a complex health field. As mentioned earlier, I look at adaptation from a broader view than previous studies in that I look at how multiple users, technology, and contexts co-evolve (e.g., physical environment and organization). I examine these adaptive practices through two case studies. The first study explores how healthcare providers use and adapt to the newly deployed system to make it fit better into their existing work practice. The second study explores how patients adapt to the sociotechnical care environment as a way to obtain information access and ensure quality care.

## **Setting**

### **Emergency Department**

This study was conducted in an Emergency Department, affiliated with a teaching hospital, which handles average 4,000 patients and more than 300 trauma patients monthly. My research team chose the ED as a field site to start exploring system adoption and adaptation because this department was the first in the hospital to see EHR rolled out. The nature of the ED

itself also added several interesting aspects for research purposes, such as the time-sensitive and information-intensive nature of the healthcare environment.

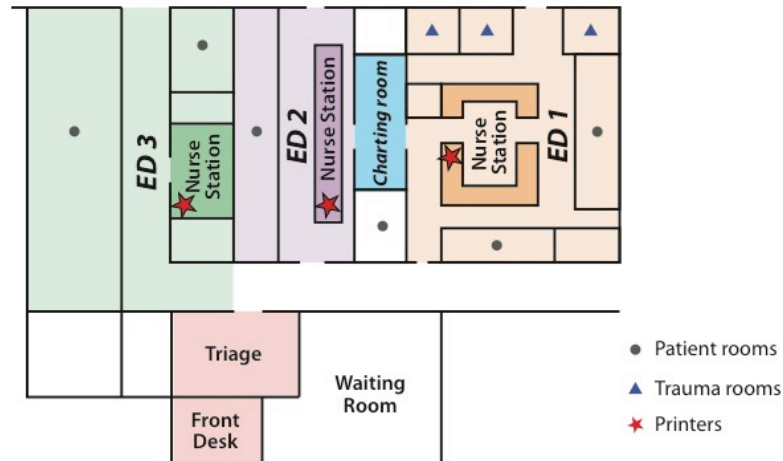
The ED being studied consists of six areas: waiting room, triage, ED1, ED2, ED3, and the doctors' charting room (Figure 3.1). The waiting room is where arriving patients (except trauma patients) check in at the front desk, then wait to be triaged. In the triage room, nurses perform an initial assessment of a patient's condition and quickly determine its urgency before handing the patient off to a nurse in one of the ED units. The ED units are divided into sections by the severity of patient illness, ranging from ED1 for the most severe illnesses to ED3 for the least severe.

ED1 is a 16-bed unit that is perceived to be the central area in the ED for severely ill and trauma patients. This unit is partitioned into 6 enclosed rooms and a large space with 10 beds separated by curtains. All beds are equipped with a cardiac monitoring machine. ED nurses are assigned with a number of beds at the beginning of each shift. For example, a nurse who is assigned to bed #1 to #4 in ED1 will be responsible for patients admitted to these beds. Patients with moderate illness or with psychological problems are assigned to ED2, which has 7 beds assigned to 2 nurses. ED3 is a 9-bed single-room unit for patients with mild illnesses, such as a cold or sore throat. It is located the furthest from ED1 and has an enclosed nursing station.

In addition, each ED unit has a nursing station where nurses of the unit stay and work during their shift. ED doctors often stop by to talk to nurses, and use the computers and printers at the nursing stations. The doctors' charting room is a separate room for doctors to document patient information, enter orders, and discuss patient cases. The charting room is located at the center of the ED, allowing doctors to conveniently walk into different ED units to

check on patient conditions. In our study, we shadowed ED staff in all these six working areas.

All of the patient rooms in the ED had bedside computers and vital sign monitors installed.



**Figure 3.1** A map of main ED area

## ED Care

The primary goal of ED care is to promptly stabilize patients' medical problems and make decisions to either discharge or admit patients; if patients are admitted, ED clinicians must choose the appropriate department and transfer the patient's care. The general ED care process consists of short patient care trajectory ranging from 1-2 hours to 1-1.5 days. In addition, ED deals with a wide variety of illnesses, which range from 1-2 hours of simple care (e.g. for patients needing stitches or patients presenting with influenza) to more serious exams (e.g., patients requiring an MRI or CT scan requiring specialist diagnosis) or the treatment of life threatening injuries.

The ED staff I studied included 4 charge nurses, 19 registered nurses (including triage and float nurses), 5 residents and 4 attending physicians, and 2 front desk clerks. The charge nurse of the ED is responsible for managing and expediting patient flow in the entire ED. Float nurses are mainly required to support any nursing work at bedsides to help the registered nurses (often in ED1 due to more critical patient cases and for the trauma patients who typically need close monitoring such as acute life support (ALS) procedures). To treat patients, ED doctors frequently interact with ED nurses, technicians, and doctors from other departments. When they visit patients' bedsides, doctors usually stop by the nursing stations to give or obtain verbal updates about the patients they manage. ED doctors have direct interaction with patients only during the initial assessment, when performing major treatments, when giving medical diagnoses and test results, and when discharging patients. Technicians and doctors from other departments often come to the charting room to report or discuss lab, radiology, EKG results, or patient admitting decisions with ED doctors.

From the ED patient's perspective, upon entering the ED, the patient interacts with a care team comprising of as many as 10 providers. Each ED patient care team is made up of a group of core members, plus several peripheral members depending on the needs of the patient. An ED patient care team is formed dynamically in situ by the assembly of a group of core team members, including an ED nurse, the charge nurse, a resident, and an attending physician upon the arrival of the patient. These core members work together to plan, update, and execute the necessary care for the patient until the patient is discharged from the ED. Peripheral members such as a float nurse, a technician, an interpreter, and a janitor may join the

team as needed. These peripheral team members would leave as soon as their designated task is completed.

The nature of emergency care practice makes it particularly worthy of research for several reasons. First, ED work is unbounded. Compared to other areas of the hospital where there are specific workload plans, EDs cannot predict or control care providers' workload based on numbers and situations of patients. The demands on emergency services are currently increasing due to an unprecedented nursing shortage; as a result, nearly all EDs these days are severely overcrowded (Trzeciak and Rivers 2003). ED care is also under significant time constraints, which can cause even heavier workloads and a more challenging workflow for providers. Additionally, ED work is characterized by a high level of uncertainty. Care providers often deal with a lack of background information about patients and need to make difficult decisions before critical data is available. Taken together, these factors make emergency work a unique environment in which to study information systems, system adaptation, and their impact on the actual care practices of providers as well as patients.

## **Technology Deployment**

At the time this study began, the ED was undertaking a significant change with the implementation of a new EHR system. The EHR was expected to change clinicians' workflow, as well as the care environment where patients are situated. Thus, this study afforded us a great opportunity to study adaptation behaviors and their underlying processes. A large-scale comprehensive EHR system, which was designed by a vendor company and was locally customized at our field site, was deployed in the ED. During the first three months of our study,



all documentation work was paper- based, until the paper system was replaced by the EHR system after a week-long transition stage. Our field observations were then carried out for another six months after the EHR deployment. This timing provided unique timing to observe nuanced adoption and adaptation behaviors and to understand the impact on the system of the paper-to-electronic notes transition – an impact which was difficult to trace in other retrospective or cross-sectional studies (Cyert and March 1963; Poissant et al. 2005).



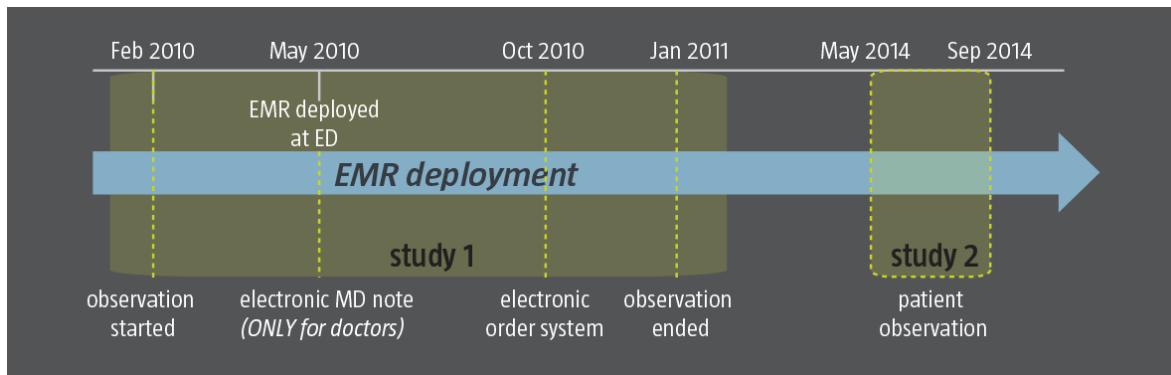
**Figure 3.2** The newly deployed EHR system and public displays in the ED 1 (a), ED 2 (b), ED 3 (c), and the ED doctors' room (d).

After the deployment, ED providers have been using the system to perform their daily work: doctors use the EHR to generate patient records, such as admission, progress, and discharge notes, and to perform ordering tasks such as labs, medications, or x-rays; triage nurses document their assessment notes in the system; and bedside nurses record their nursing care plans and conduct order-related tasks in the EHR. Other documents, such as patient flow sheets, are still in paper format at present. Also, several public displays were installed in the doctors' room (also called charting room) and nursing stations to display a "grease board", which shows real time information about all of the ED patients at glance. However, since the newly deployed EHR system and the public displays were all designed primarily for ED staff, patients and caregivers did not have any access to this information (Figure 3.2).

## **Study Approach**

To first examine the clinicians' adaptation process, I started my fieldwork in February 2010, about three months prior to the EHR deployment (Figure 3.3). The study continued for nine months after the EHR implementation to obtain a comprehensive understanding of the impacts and longitudinal adaptation behaviors in response to the system. This period of time provided me with a unique opportunity to observe the user adaptation behaviors performed by the individual ED clinicians, as well as the consequent responses at the organizational level. Then, I briefly followed up about 6 months after to just see how things were going at the field site.

Since the aim of this study was to garner a better understanding of the different aspects and forms of adaptations, including all stakeholders engaged in the same environment, I also examined patient work practices. For patients, my fieldwork included shadowing patients' complete ED journey to understand their care process and their adapting behaviors throughout the care process. My field observation for patients lasted about five months. A typical observation session started at the front desk of ED upon their arrivals, where I selected patients based on a set of criteria. I excluded trauma patients, patients with language barriers, patients with contagious diseases and psychiatric patients in this study. I describe more details of data collection and analysis for each study below.



**Figure 3.3** Timeline of the study

### Study 1: Data Collection and Analysis

We completed a qualitative field study using ethnographic methods. Two researchers, including the first author, conducted field observations and other data collection, such as informal and semi-structured interviews with ED clinicians. The goal of these research activities was to gain an in-depth contextual understanding of how ED clinicians carried out their work prior, during, and after the EHR deployment, and how different behaviors and strategies were

developed in supporting clinicians' work practices. In the study, we shadowed clinicians' day-to-day work and followed artifacts and patient flows (e.g. paper charts, admission and discharge process) to understand their work practices and workflows from a variety of perspectives. We also observed staff meetings, such as nurses' shift meetings. The study was approved by the hospital's Institutional Review Board (IRB). All the study participants verbally consented following our IRB requirements.

We have conducted a total of 230 hours of field observations over an approximately 1-year period (Table 3.1). Each session ranged from 2 to 7 hours. Observations took place during both day and night shifts, weekdays and weekends. In particular, we studied 12 residents, 9 attending physicians, 3 charge nurses, 15 registered nurses (including both triage and room nurses), 2 float nurses, 2 front desk clerks, and 1 hospital unit service coordinator. In addition, we have interviewed 8 doctors and 15 nurses to gather clinicians' perceptions and opinions regarding the EHR implementation and other related issues, such as the workarounds, that emerged post EHR deployment. The semi-structured interview explored the following three sets of questions:

- How clinicians perform their work practice (e.g., consultation, documentation, communication, hand-offs) before and after EHR deployment;
- How EHR affects the clinicians' workflows and how they deal with changes;
- Clinicians' perceived challenges and expectations for system deployment.

Interviews were recorded and transcribed for analysis. Audio recordings were discarded after transcription and the data were available only to the research team and were kept secure, as instructed by our IRB protocol.

Data collection methods.			
Role	Data Collection Method	Number of Participants	Data Collection Time (in hours)
Attending Physicians	Observation	9	40.5
	Interviews	3	2
Residents	Observation	12	60
	Interviews	5	3.3
Nurses	Observation (Informal interviews included)	23	122.5
Total data collection time			228.3
Total number of ED staff observed			46

**Table 3.1** Data collection, including method, participants, and time spent, for ED clinician study.

To analyze the observations and interviews, we reviewed all the data collected in the study to understand the ED clinicians' adaptation, with special attention to how these behaviors first emerged, and then evolved over time. Initially, we used various diagramming methods (Beyer and Holtzblatt 1997), including communication diagrams, information flow and artifacts diagrams, to understand the process of ED work practices from multiple perspectives. We also coded the field notes, including informal interviews and conversations held with participants during the course of fieldwork to obtain insights regarding clinicians' perceptions and motivations pertaining to the adaptation of the EHR-based work practice. These initial analyses helped us map out when and how the EHR system was used at work. Then, we used the open coding approach via the grounded theory approach (Glaser and Strauss 1967) to look for recurring themes regarding the differences in work processes before and after the EHR rollout. In the opening coding method, each of three authors independently and continuously compared each incident, event, quote, and instance gathered during the data collection to look for similarities and differences. Weekly discussions were held to interpret the meanings and

themes from the beginning of the study. We made sure the three researchers reached agreement about the findings of the study. Coding categories reflected a variety of behaviors of the study participants and covered both positive and negative views toward the implementations.

After adaptation emerged as the key theme from the initial analysis, we followed a process of comparing the data on clinicians' work practices before and after the EHR rollout. We extracted different types of adaptation behaviors from the data, then re-analyzed them into different categories according to the goal, stakeholders involved, and the timing when these behaviors appeared in the ED. After different adaptation behaviors were identified in the data, we then followed up with each one to trace how it was used by ED clinicians, and how it has been continually used or modified after the initial creation. This analysis revealed another stage of the adaptation process in our field site that was intended for organizational control and quality maintenance (e.g., "violation to patient privacy"). The latter form of the adaptation process was much more nuanced and was identified only after the initial analysis was completed. The longitudinal data collected in this study afforded us a unique opportunity to reveal this intertwined two-stage adaptation process. During the data analysis, we discussed our initial findings with participants through a series of informal conversations to clarify any misconceptions and verify the validity of the themes identified in this study (Klein and Myers 1999).

## **Study 2: Data Collection and Analysis**

In order to gain an in-depth understanding of adaptation practices, I spent five months conducting a field study in an ED at a teaching hospital. The methods I used included patient observations and in-depth interviews with patients, caregivers, and providers. First, I

performed patient observation sessions. I shadowed the entire journeys of 35 ED patients from the waiting room up to discharge/admission in order to understand their experiences and care process. I observed these patients as they passed through the Front Desk, Triage, and each ED units. Out of 35 patients, 14 were assigned ED1, 10 patients went to ED2, 7 patients went to ED3 and one patient was kept in Triage B due to room unavailability. The remaining three patients did not get past the waiting room stage during our observation session.

A typical observation session started at the front desk, where I selected patients based on the following criteria. I excluded trauma patients, patients with language barriers, patients with contagious diseases and psychiatric patients. This allowed me to identify the information needs of patients and the information challenges involved in an ED stay in actual situations, which would be difficult to be captured through retrospective interviews or surveys.

A total of 226 hours of observations were conducted within a span of 5 months (Table 3.2). The average observation session was 3.5 to 4 hours. Morning and evening shifts were covered on weekdays, weekends and official holidays to represent exhaustive ED work conditions. Field notes were taken during observation sessions, including all care events and clinical activities undertaken by providers, and artifacts and information exchanges among patients, caregivers, and providers. I had informal conversations with patients, caregivers, and providers only when situations were allowed (e.g., wait times at bedsides).

Second, I conducted a total 15 in-depth, open-ended interviews with patients and caregivers. I shadowed. Interviews helped uncover their attitudes, perceptions, concerns, as well as latent information needs that were not expressed verbally or visually during observation sessions. I interviewed 15 patients within two weeks of their ED visit to avoid recall bias. Open-

ended questions were devised to obtain a narrative of patients' experiences through their different phases of ED care, the information provided to them, their expectations, the challenges they faced and the feedback they had. All the interviews were recorded and transcribed for data analysis.

<b>Data collection methods.</b>				
<b>Method</b>	<b>Role</b>	<b>Number of Participants</b>		<b>Data Collection Time (in hours)</b>
<b>Observations</b>	Patients/ Caregivers	ED 1:	14	112.5
		ED 2:	10	71.5
		ED 3:	7	29
		Triage/ WR:	4	13
<b>Interviews</b>	Patients	10	10	
	Caregivers	5	5	
<b>Total observation time</b>				226
<b>Total number of participants observed</b>				35

**Table 3.2** Data collection methods for ED patient study

2For the data analysis, I and two other researchers began analyzing data by reviewing all the data collected in the study to understand the entire patients care trajectory, with special focus on the types of information and information needs patients have. Initially, we used various diagramming methods (Beyer and Holtzblatt 1997) , including sequential flow diagrams and information flow diagrams, to understand the different care phases – where any actions or events marking significant changes happened – in the ED patient care process from the perspective of different stakeholders. Some examples of care phases are as follows: the period patients spend in the waiting room; the period patients spend consulting with providers; and



the period patients stay at bedside after clinical consultation. These initial analyses helped us map out when and where patient information needs occur during ED care.

I also coded the field notes, using the open coding method from the grounded theory approach (Glaser and Strauss 1967) to look for recurring themes regarding information types, needs, and behaviors. In the opening coding method, I and two other researchers independently and continuously compared each incident, event, quote, and instance gathered during the data collection to look for similarities and differences.

After different information types were identified in the data, I then followed up with each one to find out what the information sources were used and where the breakdowns happened. This analysis revealed another stage of the patient information practices, which was how patients deal with information breakdowns and develop coping strategies.

In the following chapters, I describe the two case studies I conducted in the ED. In chapter Four, I show the ways in which ED clinicians responded to changes caused by the newly implemented EHR system and how the clinicians adapted to the new work practice over time. Chapter Five illustrates how ED patients and caregivers adapted to the care environment they encountered during their ED stays.

## **CHAPTER IV.**

# **CLINICAL WORK PRACTICE**

### **Motivation**

In hospital environments, healthcare information is fragmented across numerous different physical media and electronic applications. Health IT systems, such as EHR systems, are designed as comprehensive central information repositories, including both the medical chart and key components of the hospital work system, while also fulfilling functions such as scheduling, entering orders, and retrieving results. With recent efforts to achieve a “paperless” clinical environment, health IT systems offer considerable promise for enhancing clinical work and care quality. Thus, in this chapter I present results stemming from my study examining ED clinicians’ adaptation to their new practice after the deployment of EHR.

In the study, I found that the design of the newly deployed EHR system did not appropriately fit or support the work practices of ED doctors’ and nurses, causing unintended consequences in clinicians’ work. In order to bridge the gap between EHR-based practice and their actual work practice and overcome the obstacles introduced by EHR, both individuals and the organization made changes during the adaptation period. Clinicians engaged in an adaptation process of their own by creating workarounds to adapt to the new technology and

preserve their efficiency at work, but the organization itself (the ED department) also engaged in its own adaptation process due to the need to maintain the quality of care practices at the organizational level. I describe this detailed adaptation process as an end-user designing process. My study further reveals two stages in the adaptation process – technological and organizational adaptation.

## **Background**

In medical literature, clinicians' adaptation to a new system is often discussed as workarounds. A 'workaround' is a specific type of adaptation that is widely reported in health IT implementation literature (e.g., Koppel et al. 2008; Novak et al. 2013). Workarounds are ways of overcoming an impediment or problem brought on by the newly deployed IT system and the efforts initiated by clinicians in making the system easier to use (Azad and King 2008; Zhou, Ackerman, and Zheng 2011). Many studies have reported the emergence of workarounds after system deployment and their potential negative impacts on the quality of healthcare practices. For instance, when nurses used extra copies of barcodes, instead of scanning patient armband or medications, to work around the inefficiency introduced by the newly-deployed barcoded medication administration (BCMA) systems, this might put patient safety at risk since the important safety checks required by the BCMA system could be missing (Halbesleben et al. 2010; Koppel et al. 2008). Thus, the benefits of these health IT systems may be undermined by the risks associated with these workaround behaviors, resulting in the need to alter the technology, the work process, or management policies related to medication management.

As we have shown before, clinicians' use of workarounds can be problematic from the organizational perspective since adaptation behaviors may vary from person to person, and thus affect the standardized, consistent, and quality-assured work practices health organizations strive to maintain. Different from many other organizations, the goal of health organizations is not only to get work done effectively and efficiently; there are also numerous policies and regulations that dictate how such practices should be performed in order to ensure the quality and safety of patient care (Armijo, McDonnell, and Werner 2009). Instrumental to this are organizational and management structures to support the design and implementation of quality improvement initiatives and the creation of mechanisms for the accountability of care (Glickman et al. 2007). The role of leadership and organizational-level decisions have been emphasized in several studies with regards to the implementation of quality improvement mechanisms in organizations. In a survey of 2193 community hospitals, (Weiner, Shortell, and Alexander 1997) found that an active involvement of senior administrative leadership, including hospital management and physician representation, promoted quality improvements in the participating hospitals. (Lukas et al. 2007) also claimed that an important factor in successful organizational change and adaptation is the concept of 'alignment', which maintains, regardless of the deployment of IT systems, consistency in plans, processes, information, resource decisions, actions, results, and analysis to support key organization-wide goals.

The adaptation behaviors described earlier may have helped clinicians get work done with the system in use, but did not always follow the policies and regulations of the health organizations in maintaining the quality of their work practices. From the perspective of the

organization, certain adaptation behaviors may even lead to various safety hazards for the patient, inconsistencies in care plans, and poor healthcare outcomes (Koppel et al. 2008; Niazkhani et al. 2011). Yet, prior studies on clinical workarounds do not cover the questions of how leadership/institutions cope with the unintended consequences of individually initiated workarounds, and how organizations manage behaviors to standardize and guarantee quality care following the technological adaptation period.

To answer these questions, this study investigates the IT adaptation process of a newly deployed EHR system at both the individual and organizational levels in an emergency care setting. Specifically, this study intends to answer two questions. First, how do individual users and a health institution respond to health IT implementation; and second, how do institutions respond to the unintended consequences of the adaptation behaviors of individual users' adaptation behaviors to meet healthcare practice objectives and requirements.

## **Technological and Organizational Adaptation to the Sociotechnical System**

Although carefully designed and customized, the deployed EHR system at my field site was found to lead to many difficulties in clinicians' work practices. These difficulties consequently made clinicians find ways to adapt to the newly deployed system in order to overcome or optimize these challenges. The initial adaptation was to help individual clinicians accomplish their tasks more efficiently by reducing the immediate difficulties encountered with the system-in-use. However, many of these initial adaptations brought in unintended effects,

which posed potential threats to the organizational goal of managing the quality of care. The effects of the initial adaptation thereby led to the development of additional problem-solving efforts at the organizational-level.

## **Four Cases of Adaptation**

In this section, I describe the adaptation process that individual clinicians and the ED department engaged in through four cases extracted from our field study: (1) managing privacy after ED doctors' personal note use, (2) revised workflow and workload after centralized printer use (3) information quality control after use of tailored triage questions, and (4) policy and role creation for expediting patient flow. These cases elucidate the typical adaptation behaviors both from the perspective of individual users and from the collective goal of health quality in the ED. I chose these four cases as examples in this paper since they cover the two-phased adaptation processes from multiple perspectives, including informational artifacts, workloads, work processes, and work roles. I believe these diverse cases serve as the best scenarios to illustrate the critical needs for having both technological- and organizational-adaptations in the healthcare domain.

In each case, I will describe the two-phased adaptation process: first, the individual's initial adaptation to the system deployment, and then, the subsequent organizational adaptation intended to address the negative consequences resulted from the individual's response.

## **1. Case 1: Managing Privacy after Personal Note Use**

Soon after the EHR implementation, ED doctors started using personal notes to work around the system, since the EHR could not support collecting, retaining and transferring information from the patients' bedside to the computer. The initial workaround of paper notes served as a memory aid to overcome the inconvenience bought by the EHR system. With the EHR system in use, ED doctors found the computer system could not support bedside documentation efficiently, since the doctors felt that typing out all the required information in front of patients was too time-consuming, and they preferred to have natural, face-to-face interactions with patients. As a result, doctors had to memorize all relevant information they had gathered at the bedside in order to document it later in the charting room. Memorizing patients' information is particularly challenging when a doctor has to take care of multiple patients at the same time. To make the deployed system fit in their actual workflow, doctors therefore created a workaround to use paper notes as a memory aid (Figure 4.1). On the personal notes, doctors first jotted down basic information for each patient (e.g. bed number, age, chief complaints, medical history), and then updated these notes to record new procedures and medications. As we observed in the study, ED doctors actively developed different customized strategies in using the personal notes: some compiled a set of questions to mirror the structure of the formerly used paper charts; others even drew separate tables to organize multiple patients' information to manage multiple patients' situations concurrently. The use of personal notes was an adaptation behavior ED doctors actively engaged in to make their work easier to perform, and to make the deployed system workable.

Despite the benefits of having these personal notes at the ED, this convenient, hybrid paper-electronic documentation introduced new concerns among the ED leaders regarding patients' privacy. Most of the notes contained private patient information, and should have only been accessible to those involved in the patient case. As observed in the study, paper notes were, at first, discarded everywhere after use – piled up on desks in the charting room, left next to computers at nursing stations, left in scrubs or lab coats previously worn by ED doctors (Figure 4.2). Sometimes the notes were even brought out of the ED environment accidentally. Since there were no rules regarding how to manage the paper notes when the workaround was first developed, paper notes were easily misplaced or left unattended after use.

In order to address the concern of potential privacy breaches, the Associate Chief Medical Information Officer, who was also an ED attending physician, suggested all ED doctors utilize electronic “triage printouts” as their personal notes. Using triage printouts instead of random paper scraps, allowed doctors to easily recognize and distinguish personal patient notes from other papers, and prevented doctors from taking notes on patients on random paper scraps. Similarly, a “shredder box” located in the charting room was deployed to manage paper notes in a centralized manner.

Doctors were required to discard their notes in the shredder box after use. The collected notes in the secure shredder box were then disposed centrally by the ED department. After this new internal rule was implemented, the use of triage printouts as personal notes and discarding of them in the shredder box soon became common practices in the ED. Now, all the private information documented in the initial workaround is controlled centrally. This collectively adaptive behavior enacted at the department level enabled the ED to control the distribution of



personal notes and protect the patient privacy that may have been at risk by the initial behaviors of the doctors.



**Figure 4.1 (left)** Personal note use (carried by doctors)

**Figure 4.2 (right)** Personal notes left on the desk from another resident, after charting at computer

This case of personal notes clearly demonstrates the importance of two-phased adaptation process in the ED. First, to continue working with the newly deployed system, doctors used paper notes as a memory aid for remembering patient care information. This initial adaptation worked around the original system design, and made intensive ED documentation work possible. Nevertheless, this initial workaround soon led to another issue in the workspace – the possible mismanagement of the private patient information in the doctor’s notes. Second, to address the consequence of this workaround, the ED administrator decided to manage, store and discard the used personal notes through a single, reliable disposal method (the shared shredder box) and through a single physical medium (triage printouts). The latter phase of the adaptation was for the ED to prevent any potential negative impacts resulting from the doctors’ initial adaptation to the new technology.

## **2. Case 2: Revising Workflow and Workload after Using a Centralized Printer**

The use of the EHR did not only change the clinicians' documentation process, it also impacted the ways in which clinicians processed orders. Prior to EHR use, ED doctors could print out transmittals using any computer and any printer. A transmittal is a printed copy of electronic lab order that must be sent along with each lab sample in order to verify the status of the order. After the transmittals were printed out, doctors would bring printouts to the nurses so that the nurses could administer the orders. Nevertheless, after the EHR deployment, doctors were no longer able to print the transmittals in the old means for security reasons, the system only allowed doctors to print the transmittals from the computer in which they had initially logged on. Because of this, doctors were not able to print orders out at just any printer. Instead, they had to remember which computer they first logged in on to know where the transmittals would be sent. As a result, many ED doctors constantly complained about not being able to retrieve printed transmittals from the right machines. To fix this problem, the Associate Chief Medical Information Officer reported the printing problem to the hospital IT department, and the IT team redesigned the printing system to make all transmittals print from a single printer located in ED 1 (see Figure 3.1). This change simplified the abovementioned issue by allowing doctors to use any computer to print, with the printouts coming only from the ED 1 printer.

However, despite the convenience of locating printed orders in the initial adaptation, using the centralized ED 1 printer complicated the ED doctors' workflow significantly, since they now had to walk to ED 1 to pick up transmittals, a location that was often far away from patient rooms, particularly for ED 3 (see Figure 3.1). Consequently, this change caused many interruptions in the ED doctors' workflow since doctors had to go over to the printer at ED1 to

pick up the transmittals frequently. To overcome this inconvenience, doctors often asked other residents or nurses to pick up printed copies on their way to or from ED1, or waited until three or four orders were printed so that they could pick them up all at once. When doctors were busy, they occasionally even forgot to pick the orders up. During the observation, we saw the printed transmittals pile up on the ED1 printers, leading to the possibility of misplacement or delay in patient care.

To address the possible problems of lost transmittals and delays in patient treatment brought about by this initial adaptation process, ED clinicians later unanimously made a decision to shift the task of printing transmittals from doctors to nurses. It is now the nurses' responsibility to check orders, and print and pick up transmittals after the doctors enter them in the system. Although this new work process seems to give more tasks to nurses, surprisingly, most nurses enjoyed having more control over the ordering process, since they were able to execute orders more quickly, instead of waiting for doctors to pass them along. This change in responsibility also allowed doctors to concentrate more on their own work without being interrupted to pick up and send transmittals to the nurses. Doing so also eliminated potential delays in the patient care process. Shifting responsibilities pertaining to the transmittals improved work efficiency for both doctors and nurses and ensured continuity within the patient treatment process.

In the printing of transmittals case, our study revealed that the inflexibility and inconvenience of the initial printing setup forced ED administrators to create a centralized printing system as the initial adaptation in allowing easy printing within the EHR system. Nevertheless, upon discovering that the centralized printing system also distracted doctors

from their workflow and caused a delay in the ordering process, ED clinicians then redistributed the transmittal management responsibilities from doctors to nurses. The latter adaptation, notably, does not change the design or configuration of the system, but rather changes the workflow and workload shared between ED nurses and doctors. This adaptation was made at the organizational level, where a norm was developed based on the shared understanding and expectation among clinicians in order to achieve the collective goals of work effectiveness and patient care quality.

### ***3. Case 3: Controlling Information Quality and Use of Tailored Triage Questions***

Similar to the case with the doctors' electronic documentation practices, the shift to a digital system in the triage room also led to a two-phase adaptation in optimizing the triaging process. The goal of triage is to conduct an initial medical assessment and quickly decide to which ED unit the patient should be admitted. Triage nurses are responsible for gathering necessary information from the patient in order to make a rapid decision about a bed assignment, and filling out the Medical Screening Exam (MSE) form. The MSE form is then shared with ED doctors and bedside nurses. Compared to paper forms, the electronic MSE dramatically increased triage time in the ED. This is because the paper MSE covered only key questions (e.g., medical history, allergies, or medications) that could be completed in 5-7 minutes, whereas the electronic MSE requires at least 10-15 minutes to complete. This detail-driven but more time-consuming documentation resulted in prolonged triage documentation and made the triage a bottleneck of ED patient flow.

To speed up the triage process, nurses developed a workaround through “tailoring” the questions in the electronic MSE form by asking only selected questions they believed to be relevant for a given patient. The use of tailored questions was able to reduce the triage charting time to almost the same as paper charting helped nurses move onto the next patient quickly. However, despite the shortened triaging time, this initial workaround led to a new problem of information inconsistency and that could jeopardize the quality of patient care, since there was no standard on how questions should be tailored. Sara, charge nurse told us:

*“[Charge nurse, Sara] There’s no consistency. So, not everybody is always checking all the same boxes. Some people – there are certain things that are supposed to be checked, but not everybody is checking it. Like, they ask you, have you had a recent weight gain or weight loss? And Marla (educator) tells us that’s important. But not everybody’s clicking those two boxes. And it’s a yes or no question. So, there are some inconsistencies, as when people are triaging.”*

As Sara indicates here, the question tailoring process was largely done by individual nurses and lacked consistency on how questions should be selected. Nurses could ask different questions based on their own preferences. As our observation showed, when reviewing the MSE during patient consultations at the bedside, ED doctors sometimes found that, for patients with similar illnesses, different information had been collected and sometimes crucial information about a patient’s medical history was missing in the notes.

To resolve this issue, the ED Clinical Educator, who examines clinical requirements for the entire department, redesigned and deployed a new version of the electronic MSE, called Rapid Screen Exam (RSE), to be used in the EHR system. Different from electronic MSE, RSE includes a short list of required questions, such as chief complaints, height and weight, vital signs,

medication list, and any medical history related to the current complaint. It also has a flag function that uses exclamation points and asterisks to indicate important questions that cannot be by-passed. If nurses fail to enter an answer for questions marked with exclamation points, the system marks the document as incomplete; and if an important asterisked question is left uncharted, the system will not even let nurses save the form. After the RSE was rolled out, triage nurses could document important baseline questions while maintaining the consistency of all triage questions simultaneously.

Similar to the use of standard personal notes and the use of the shredder box to control the distribution of private patient information, in order to adapt to the EHR-based triage practice, ED clinicians revised their initial workaround and deployed a new protocol, RSE, to maintain the consistency of information collected in the triage process. The latter adaptation was designed to alleviate the potentially negative impacts brought in by the initial workaround adopted by triage nurses. Notably, the ED staff responded to this problem in a more formal manner, by implementing a new electronic triage form in the EHR system. This is because the risks entailed by the question-tailoring behaviors could have serious impacts on the quality of patient care in the ED and could directly affected the collective goal of quality control and improvement in the entire ED.

#### ***4. Case 4: Creating a New Coordinating Role in the Department***

As we described in the previous case, the increased waiting time with electronic triage became a bottleneck in ED patient flow, affecting the overall operation of the entire ED. Since quick patient turnaround is considered critical in ED care, in addition to the shortened triage

documentation process, the department made another effort to expedite the patient workflow by deploying a new procedure to send patients directly to beds without triaging.

To solve the problem of the prolonged patient waiting time, a committee including ED faculty, the ED nursing director, and the Chief Information Officer decided to apply a procedure called Pull-to-Full to bypass the triage process. Pull-to-Full allowed staff to send patients directly to ED rooms based on a patient's chief complaint as assessed at the front desk of the waiting room – without being triaged. The initial detailed assessment, which was previously conducted by triage nurses, was now performed at the bedside by a regular nurse. The procedure was carried out in the 7am to 11am timeslot on a trial basis. During this timeslot, the triage was closed and two triage nurses working at the front desk quickly interviewed patients and acted as a transporter to bring patients to ED units directly. Most patients were brought to ED3 (which is for the less severely ill patients) unless their case was very urgent or they needed heart-monitoring equipment, e.g. for chest pain. Then, the triage nurse briefly reported the patient's situation to a bedside nurse when handing the patient over. For example, when a patient arrived at ED3, guided by a triage nurse, the triage nurse verbally provided a minimum amount of information, such as the chief complaint, and wrote 1-2 lines on the nursing note. An ED3 nurse then conducted an initial assessment at the bedside – the assessment which would previously have been conducted in triage.

Although the Pull-to-Full procedure accelerated patient flow by reducing patient waiting time and solved the issue of the overcrowded at ED waiting room, it resulted in several consequent issues in patient care. First of all, since the detailed triaging process was skipped, the lack of appropriate patient information often resulted in incorrect decision-making, and

patients were often found to have been assigned to the wrong ED unit/bed. For instance, we saw a patient assigned to ED3 because of abdominal pain, but after a more detailed assessment, it turned out to be a psychiatric patient who should have been sent to ED2, which is equipped for patients with psychiatric illness. These erroneous allocations occurred frequently, and patients had to be moved a second time. In addition, the Pull-to-Full procedure also increased the workload of ED3 nurses since they had to perform triage work on top of their regular duties. This problem was exacerbated when more than two patients came to the ED at the same time. If more than two patients arrived at the same time, and all ED3 nurses were already engaged in triage work, the newly arrived patients could have to wait in their beds for a while before they could be triaged and treated. Consequently, the increased workload for ED3 nurses affected the other care team members' work in the ED. For instance, sometimes when doctors arrived at the bedside, the patient had not yet been seen by a nurse, meaning vitals had not been measured and were not available for the doctor. During our observation, Adam, a resident, expressed his frustration about this new procedure: *"The process can be messed up. Sometimes I go first [before a nurse triaged a patient], and nurses even don't know whether I've been there or not [since the nurses are still busy triaging the previous patients]."* This quote illustrates the consequences of nurses being held up by the triaging work at bedsides; during busier times, the nurses were not able to provide the necessary information (e.g. vital signs) for the subsequent care team members – such as doctors – in a timely manner.

Since the original workaround was found to lead to the abovementioned issues, consequent adaptation efforts were made by the committee to create a new role called *"Triage Care Coordinator (TCC)."* The role of the TCC aimed to address the shortcomings of the Pull-to-



Full procedure, and to reestablish the function of triage work in the waiting room. The TCC's job is to increase the efficiency of triage by making quick decisions for incoming patients at the front desk based on their chief complaints. The TTC conducts an expedited triage for patients with only urgent matters (e.g. chest pain patients) by sending them directly to ED1; the other patients continue waiting for their turn and have to go through a conventional triaging process. With the creation of the TCC role, time is saved for all the patients by sending urgent patients directly to the units. It also resolves the issues of potential bed-assigning errors and the work over-load of ED3 nurses due to the lack of a triage work process. The creation of this new role reflects the department's appreciation of the importance of triage work's function after the Pull-to-Full trial period.

To summarize, to respond to the slow patient flow in the ED, the Pull-to-Full procedure was initially deployed at the ED by sending patients directly to ED units. However, this new procedure has found to lead to many undesirable breakdowns, such as imposing more workload on ED3 nurses, and consequently making the doctors and other nurses' workflows inefficient. Since the initial adaptation highlighted the critical importance of having rapid assessment, particularly obtaining vital signs early on to make the right care decisions for patients before sending them to the bedsides. To resolve the breakdowns from the first adaptation, the ED administrator created a new role, keeping the positive aspect of the Pull-to-Full procedure while eliminating the detrimental ones. With the consequent adaptation, the ED was able to resolve the issue of the prolonged waiting time, as well as to address the problems encountered by the initial adaptation.

## **Discussion**

The EHR system at our field site was designed to serve as an information infrastructure supporting clinical documentation and other work activities. However, we found that the system implementation impacted ED clinicians' work practices, creating challenges in documenting patient charts, printing lab orders (transmittals), and performing triaging work. In handling these challenges, clinicians at our field site engaged in a two-phased adaptation process. First, there were initial, immediate adaptations to make the system fit within the clinicians' working environment. Later, in order to ensure the quality of patient care and work practices, a series of consequent adaptations were deployed to address the potential negative impacts resulting from the initial adaptations. These two adaptation phases are both necessary since getting work done and controlling the quality of work are equally important in healthcare practices where high reliability is crucial.

In this section, we first discuss the distinct nature of the two phases identified through this study. Then we discuss the design needs for organizational adaptation in high reliability fields such as healthcare. Finally, we conclude with some suggestions for socio-technical-political system adaptations for practices in these domains.

### **Adaptation as an End-User Design Process**

In my study, ED clinicians adapted to the new EHR system by creating several workarounds. This can be viewed as a process of redesigning computer systems and work

practices through doctors' own active engagement. When the EHR deployment created problems in clinician's work practice, they made efforts to fix these issues by creating workarounds. In the process of developing workarounds, ED doctors and nurses transformed their role: from users of the EHR system, they became designers engaged in the design of the socio-technical system through the process of adapting and improving the original EHR design.

In this redesigning process, doctors and nurses were engaged with the use of different tools, such as the system, other artifacts, and the physical environment, to achieve their work goals. In particular, triage nurses worked out with the electronic triage note by tailoring sets of questions to reduce triage time; the doctors worked out with the EHR use by extending the documentation system to include paper personal notes; and finally, when the system impacted the work practices in the entire department, the department leadership made collective changes by adapting and setting up new policies to benefit the entire ED, allowing doctors to expedite collaborative work for lab orders. Therefore, my analysis suggests the importance of looking beyond the computer system itself when studying adaptation processes for socio-technical systems. In this case, tools are even extended to encompass new artifacts and new printing system. These tools are part of the working system that mediates between clinicians and their work goals. However, these tools which exceed the bounds of computer systems are not always recognized and incorporated in the system design process.

In fact, adaptation is a critical process in designing sociotechnical systems in medical practice. Since healthcare is a highly complex field with an extremely dynamic working environment, a good system design requires not only knowledge of HCI but also sufficient understanding of clinicians' work practices (Chen 2010; Reddy and Dourish 2002; Bardram and

Bossen 2005). This is often referred to as symmetry of ignorance (Poissant et al. 2005) in the HCI field: designers and clinicians lack knowledge of each other's specialized domain, and are therefore unable to communicate effectively and understand each other. The gulf between designers and end-users is even wider in the case of a complex domain, such as clinical practices. Thus, even when clinicians are invited into the design process, they may not be able to recognize and articulate potential problems. Because of this, the final adaptation stage after system deployment is inevitable and system designers will benefit if they can learn from the adaptation process. As was evident in the study, clinicians were forced to participate in redesigning activities and solving problems during the adaptation period, since no designer would know enough about their work practices to help them adapt the system use. The adaptation of new system requires ED clinicians to go beyond being passively learning to use the technology as end-users, and puts them in a position to actively consider and create new workaround systems—a position which is essentially a design position.

## **Technological and Organizational Adaptation to the Sociotechnical System**

### ***1. Making Health IT System Work and Making Healthcare Practices Accountable***

The four cases described in the paper, though with different goals, tasks and stakeholders, all demonstrated that there is a two-phased adaptation process that first aims to respond to the direct impacts of a newly deployed information system – technological (immediate) adaptations, and second, uses organizational control to manage the quality and variability of work practices, leading to organizational (consequent) adaptations. Technological

adaptation is the prompt response that attempts to alleviate the immediate problems introduced by the IT system, such as problems that directly and obviously impact clinicians' workflow and cause breakdowns in their work. Technological adaptations tend to emerge in the early stages of the system adaptation process since it is driven by the use of technology. Organizational adaptation is the consequent response designed by healthcare organizations to alleviate the issues that emerge when solving the immediate problems. In particular, organizational adaptation aims to control the quality of healthcare practices in order to have consistent, efficient, and effective care that complies with the unique requirements of healthcare practices, e.g., privacy protection or medical errors.

The main characteristic of technological adaptation is that it tends to be a "quick fix" that makes the system workable and fits into the clinicians' work practices. As we described earlier, initial adaptations are mainly for solving or working around the obstacles, breakdowns, or other problematic situations resulting from the system deployment. As such, technological adaptation arises to address the instantaneous, direct impacts of technological use soon after the EHR enters employees' work practice. Since system use interferes with their original workflow and work routines, clinicians become actively involved in immediate problem-solving activities; they strive to locate the flexibilities of the system design and develop new ways of working with the system. Similar technological adaptations have been reported in prior organizational studies. This includes a focus on the role of human agency in enactments of different technologies in organizations, such as appropriation and improvisation technology-in-practice enacted by individual workers (Orlikowski 2000), as well as improvised learning and reinvention processes to work around system constraints in unintended ways (Boudreau and

Robey 2005). However, these prior studies were not conducted in the healthcare domain and the adaptation behaviors reported were acceptable in organizations as long as they addressed the initial challenges of system use. Furthermore, our work offers a stance on workarounds by considering them instances of conscious, positive action. As compared to most previous works have seen them as an unintended consequence of system deployment, we see them as an effort driving the inevitable and robust process of adaptation to the new practice – a view which aligns with our previous work and Flanagan’s recent work (Park and Chen 2012; Flanagan et al. 2013).

In our study, doctors and nurses developed various adaptive behaviors, also known as workarounds, in the process of solving immediate problems. Soon after system deployment, clinicians tried to negotiate with the system in use and make work possible, meaning if they can adapt or alter the system itself, they do; or if they cannot, they create new tools (e.g. paper notes) or reconfigure the physical work environment (e.g. relocating printers). For example, in the case of the electronic triage charting, triage nurses realized that the lengthy questions being asked in the EHR did not support the goal of fast triage work at the ED (problem as a direct impact of new system deployment). As an immediate response, nurses started tailoring the questions on the electronic MSE form in order to shorten the triage process (making the system workable). With similar goals, in other cases, clinicians had to utilize paper notes as a workaround to memorize patient care information, or to reconfigure the setup of the printing system to overcome the issues directly introduced by the use of EHR.

Nevertheless, these immediate technological adaptation behaviors, although effective, were soon found to be problematic by the ED leadership, mainly because they were inconsistent

with the goals health organizations strive to maintain. Take the personal notes case as an example; the potential privacy infringement introduced by the first phase of adaptation led to the consequent policy on how and where the notes should be discarded. The latter adaptation would not have been developed if there were no pervasive use of personal notes in the ED, and the deployment of the new procedure is regulated by the strict privacy requirements in healthcare organizations. In other words, the organizational adaptation process may not have existed in other domains if privacy was not the foremost requirement in the work. Similarly, when triage nurses tailored and shortened triage questions, the doctors who carry the next step of patient care started noticing missing or discrete information on the triage note. This issue was reported to the ED clinical educator and she started investigating this information issue because inconsistent information can dreadfully affect patient safety and the care quality of ED work. Likewise, across all four cases, the unintended outcomes induced by immediate adaptation in reaction to new technology interfered with institutional/organizational goals that the healthcare organization strived to maintain, and thus led to the consequent organization-level adaptation process. In our study, these were often identified by personnel who oversee the overall clinical work process but also work closely with individual clinicians, such as the Associate Chief Medical Information Officer and ED clinical educator.

Thus, the organizational-level adaptations were created and deployed at our field site mainly for the purpose of mitigating the potential hazards introduced by technological adaptations to maintain the quality of practices in a health organization. Our analysis found that organizational adaptations tend to respond to organizational-level impacts of system deployment to make the healthcare practices more accountable and comply with the quality

measurements required in the field. Once a technological adaptation is used to quickly fix the direct impacts of the system, it can lead to tensions between the efficiency of work and the strict organizational goals in healthcare domain since quality assurance may not always align perfectly with the work efficiency. Contrary to fixing immediate breakdowns, the need to control the quality of practices is less visible. Consequently, organizational adaptations often become necessary after the initial technological adaptation with the intent to address the consequences of the initial adaptation only. In our research we found that in response to this need, organizational adaptation is designed as a commonly agreed practice, imposing a new work norm, and affecting work culture and work policy. This consequent adaptation is specifically designed to cater to the unique needs in healthcare practices and management – i.e., care quality, data quality and standardization, and patient safety and privacy in the ED, whereas the immediate adaptation is only to provide an immediate fix to the negative impacts caused by the system.

For instance, in the earlier example of EHR-based triage work, doctors and ED clinical educators recognized that the nurses' work practice of tailoring questions led to a problem concerning inconsistency in patient information, and possibly jeopardized the quality of patient care (tension created by technological adaptation). As a result, to maintain information consistency in triage nurses' use of the electronic MSE as well as shorten the triage charting time, the ED clinical educator had to compare the previous work practice with paper triage notes and the questions the electronic system required nurses to ask. This resulted in a shorter triage question list being developed, while maintaining consistency between the questions asked by each nurse. The RSE, a new version of the electronic MSE, was developed to ensure

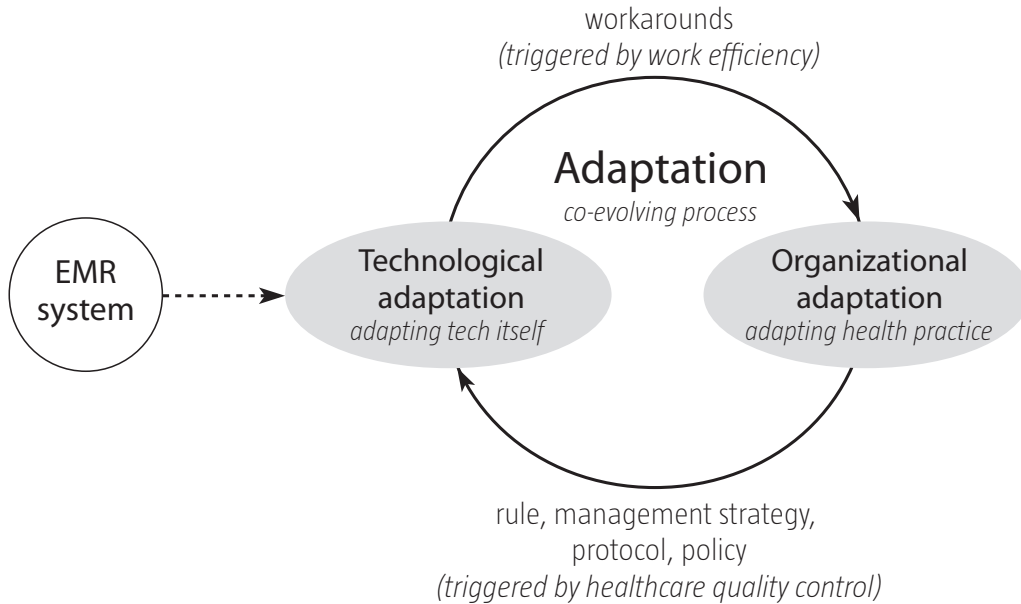


both care quality and efficient patient flow to fulfill organizational goals. The consequent adaptation could potentially improve the quality of healthcare practices since both work efficiency and patient safety have been improved after the second adaptation. In particular, by making the questions consistent but shorter, the organization ensured that all ED patients were examined in a standardized, but quick manner. Across all cases, organization adaptations serve similar goals, namely, improving and controlling the quality of care after the system is adapted and workable in the ED – e.g., the deployment of a shredder box and triage copies for patient privacy, the re-distribution of labor in printing transmittals for work effectiveness and patient care quality, and the creation of a new TCC role for rapid patient flow and reducing medical errors. Therefore, these consequent, organizational adaptations are devised in a more top-down manner and reflect a concern for homogenizing work processes and performance within the department/institution through the deployment of organizational-level decisions and policies.

In prior literature on organizational learning, technological and organizational adaptations are similarly manifested as “first-order and second-order problem solving” (Tucker and Edmondson 2002; Argyris and Schön 1978; Vogelsmeier et al. 2008). In particular, Tucker and Edmondson (2002) studied nursing problem-solving behaviors and found that, other than direct problem solving activities made by frontline health providers, organizational-level interventions, such as training, rewards, and workload balancing, were implemented to leverage individual behaviors. This research suggests a dual individual- and organizational-level model in responding to routine exceptions in healthcare context, where the first-order problem-solving is an approach that seeks to remedy only immediate problems by working around them, and the second-order problem solving is an attempt to remove the underlying

causes of the problem so that the problem does not reappear. The identification of the second-order solving in meeting quality requirements in healthcare delivery environment is similar to the organizational-level adaptation found in our study. However, this empirical study was based on the responses in exceptions occurring during routine healthcare practices, instead of investigating the impacts and user responses after major work process shifts; in contrast, our case focuses on the implementation of a large-scale health IT system, and provides useful insights for future technology implementations in healthcare domain.

In addition to the first- and second-order problem solving behaviors, our work tackles the process of adaptation and how the first order changes relate to and trigger the second order changes in a domain requiring high quality standards. We argue that immediate adaptations arise from the process of adapting to technology itself; and the consequent adaptations arise from the subsequent process of adapting to the healthcare practice that requires conformity with certain goals and regulations, and the fulfillment of certain needs and objectives. This implies that the development of the adaptation process while using, altering, and adjusting to new technology and work practices is likely to be a lengthier process rather than a quick fix. Nevertheless, the nature of these two distinctive types of adaptations, which exceed the bounds of the computer system itself and encompass protocols, roles, and policies insofar as they interface with organizational impacts, is not always recognized and incorporated into system implementation.



**Figure 4.3** Technological- and organizational adaptation process model

## **2. The Need for Organizational Adaptation in High Reliability Domains**

Although adaptation in general has been frequently studied in prior literature (Ash, Berg, and Coiera 2004; Boulus and Bjorn 2010; Cyert, March, and others 1963; Hersh 1995), many studies focused on how users adapt to technologies to make their work possible (e.g., overriding medication alerts, Koppel et al. 2005). In particular, in the healthcare context where this study was carried out, many prior researchers have revealed and studied the ‘workaround’ – a type of adaptation behavior that creates new ways of using and navigating the system to make it workable. Our study shows that clinicians create various workarounds as ways of adapting to the difficulties and breakdowns imposed by technologies immediately after deployment. In addition to the initial adaptation efforts, the organization has to modify and develop consequent means to collectively manage the initial technological adaptations. We found that the goal of controlling the quality, and consistency of work practices led to the

organizational level adaptations at our field site. Compared with other studies on organizational adaptations, organizational level adaptations in our study are deeply rooted in the goals of healthcare practices, and can be applied to many highly reliable fields.

Quality control, as a collective goal, is critical to healthcare practices where the goal is not only to get work done, but also to conduct it according to quality control guidelines (Joseph and Godfrey 1999; Kepner and Tregoe 1976). Our empirical study conducted in the ED reveals a conflict between two parallel sets of goals in responding to the new technology implementation – the individual caregiver’s pursuit of efficiency at work, and the institution’s pursuit of quality control. When clinicians improve individual task efficiency using immediate workarounds, this may negatively affect the institution’s ability to pursue collective goals and eventually create a need for institutional-level decisions. In contrast, when the department or institution regulates clinical work for the purpose of care quality control, this directly affects the ways individuals perform their work. Hence, the problems in healthcare practice cannot be easily “fixed” in a single step (workaround) or using a single, one-time set of measures to achieve the clinicians goals; the institution’s collective goals must also be taken into account for the problems to be truly solved.

As our study shows, technology implementation and adaptation is an ongoing, mutual transformation of the health IT system and the organization. Technological adaptations are initially developed to cope with the direct impact of system deployment. Subsequent organizational adaptations are then implemented to alleviate the problems caused by the immediate response (i.e. initial workaround use). Through this process of reflecting and balancing the needs of both individual caregivers and the caregiving institution’s organizational

concerns, adaptation by ED clinicians and the department emerges during the time period following the system deployment, and can be seen as a co-evolving adaptation process. A co-evolving process is a stabilization of efforts between two types of adaptations during the adaptation period; it is a crucial practice that enables both individual clinicians and the collectivity of the caregiving facility to negotiate and harmonize the pursuit of their respective goals when adapting to the new work practice (Figure 4.3).

In addition, during the co-evolving process, it is especially important to examine why these two types of adaptations occur in this particular order. Our study offers insight into this phenomenon insofar as it indicates that clinicians do not necessarily welcome off-the-shelf systems; instead, they need to actively devise ways of incorporating the EHR system effectively into their local workflows by developing different workarounds while they are using the system. However, it is obviously not desirable for clinicians to make unrestricted use of workarounds without regard for institutional goals and regulatory requirements. This is why the two types of adaptations take place in this order – users first need to integrate the system into their work to achieve their work goals, then require another round of adaptation to ensure that these modified work processes still fulfill organizational goals. This specific order for two adaptation types is relatively distinct in relation to prior adaptation models in organizational studies, such as adaptation as a gradual process of reducing misalignments (Leonard-Barton 1988), a discontinuous process (Tyre and Orlikowski 1994), and as a sporadic and ongoing process of modifying existing structures (Majchrzak et al. 2000). This is because the second adaptation arises specifically as a result of certain structures, rules and requirements that are unique to the healthcare work environment. We do not advocate that this particular order – the

sequence of technical first and organizational later – be considered a “gold standard” for clinical IT system implementation, nor should it be universally followed and adapted. Instead, we believe that the ongoing co-evolving process between technological adaptation at the work-efficiency level and organizational adaptation at the institutional and policy level should be recognized and should inform adaptation processes by clinical IT. Therefore, it is our view that the co-evolving process is necessary, as both types of adaptations are required to co-exist side by side to meet individual work efficiency and collective organizational standards, which represent essential needs in healthcare practice.

## **CHAPTER V.**

# **PATIENT ENGAGEMENT DURING HOSPITAL CARE**

In the ED, patients are the other major stakeholders and the providers' counterparts. Although patients are not direct users of the current health IT systems, they are affected by these systems and could be users of the systems in the future. Nevertheless, my earlier studies on providers' work practices show that patients are largely left out of current system designs; in fact, they suffer from a severely imbalanced information environment in the ED. This information imbalance is brought about by a disparity in information access between patients and health providers. Patients struggled with inadequate access to information during their stay, while providers were busy with an abundance of time-critical and dense information, as well as the tasks required for different information systems (Gordon, Sheppard, and Anaf 2010). This inappropriate information access leads to a barrier preventing patients from further participating and engaging in their ongoing care, especially when patients in the ED may encounter a wider range of stressful situations requiring more knowledge, scrutiny and planning. Thus, it is crucial to examine the specific challenges patients deal with based on their information needs, expectations and behaviors, and to incorporate them into the future designs of the health IT systems.

In this chapter, I describe my second field study, in which I examined the information breakdowns patients faced during their ED encounters, and the needs and strategies they developed to handle the breakdowns. Through the study, I identified that ED patients actively engaged in deploying various coping mechanisms to find any available information and sources in adapting to their care situations, which is similar to the adaptation practice in the clinician study (chapter 4). This work contributes to the research community by identifying new forms of behaviors that patients engage in to adapt to the sociotechnical environment they suddenly encounter, and by discovering design opportunities to support information behaviors and needs for patients during emergency care.

## **Motivation and Introduction**

Meeting the information needs of patients is imperative to increasing their participation and satisfaction in and with their own healthcare. Despite the necessity of providing patients with information related to their care, the design of health IT systems is often oriented towards the healthcare providers' needs, particularly in clinical settings. This means patients have no or very limited access to health-related information, and must rely heavily on their healthcare providers for obtaining their information. Without adequate information access, patients suffer from a lack of awareness of the care they receive, an inability to actively participate in their own care, and inefficient patient-provider communication. This indicates a critical need to reconsider the design of information systems to incorporate patients' information needs.

Due to the nature of emergency care, the ED is an environment where patients usually



face severe difficulties when seeking the fulfillment of their information needs and engaging in their own care. Prior studies (Eisenberg et al. 2005; Park et al.2012) have shown the complexity of emergency care to include uncertainty, time constraints, interruptions and frequent staff changes; such characteristics often lead to barriers in patient-provider communication. These barriers, in turn, make it even more challenging for patients to receive health information from their providers, impeding them from actively participating in their own care (Eisenberg et al. 2005; L. Wilcox, Morris, et al. 2010). My previous study (Park et al. 2012) shows a radical contrast where ED providers are busy with time-sensitive care for multiple patients, dealing with short patient turnaround rates, and juggling many different information systems to complete their care tasks, while ED patients are frequently left uninformed of the details of their care related information, and face a myriad of uncertainties. For instance, patients experiencing unexplained pain undergo uncomfortable procedures without necessarily being notified about the results or the tests' significance and often have to wait passively for updates on what procedure will come next. This is because ED care providers have insufficient opportunity to communicate information to patients in a timely or efficient manner (Gordon et al. 2010; Watson et al. 1999). In short, ED patients suffer from a significant information deprivation and have unmet needs for real-time, ongoing health information during the care process. This situation demands effort on the patients' part to deal with or adapt to this challenging care environment in order to receive the care service they need.

Currently, the patients' need for information access is not adequately supported by the available technologies in this environment. While EHRs are designed for clinician-driven needs

and have been widely implemented, there are barely any systems for patients to use while they are in the clinical settings. One widely used patient system, Personal Health Records (PHR), is designed specifically for patients to review and manage their medical records online, but the PHR is intended for use outside of the ongoing care context, mainly for access to information before, after, or in-between clinical visits (Tang et al. 2006). The numerous existing mobile health applications designed for patients to search, track, and record health-related information, such as glucose levels, heart rate, and step counts, are not offered to patients in clinical or emergency care settings as well (Committee on Quality of Health Care in America 2001). Thus, most existing health IT systems do not provide information to patients during hospital stays or emergency visits, where patients undergo unmet needs in terms of receiving situational information in real time.

In the HCI and Health Informatics communities, very few recent studies have recognized the need for patients to access their health information in real time during their hospital stay (Wilcox et al. 2010; Bickmore et al. 2009; Porter et al. 2004; Wilcox et al. 2010), and even fewer have focused on the emergency care setting (Wilcox et al. 2010; Wilcox et al. 2010; Pfeifer Vardoulakis et al. 2012). These studies use real-time information from EHR systems, providing patients with access to that information during their hospital stay by using tools such as information displays in patient rooms (Wilcox et al. 2010; Bickmore et al. 2009; Wilcox et al. 2010) and mobile phones (Pfeifer Vardoulakis et al. 2012). However, these studies do not address the specific types of information patients need or desire to have, nor do they consider the details of current patients' information practices, such as what information sources are

available/unavailable, the questions of when and how patients obtain or fail to obtain such information during their hospital stay, and how they cope with information breakdowns. By recognizing the challenges in accessing information in an information-deprivation environment, this study aims to examine the details of how patients adapt to the unfamiliar clinical environment they immediately encounter, where they have to manage information, yet have no access to it. Specifically, I analyze the underlying components of healthcare information that patients need or desire to have by investigating the information sources that they currently use, types of information breakdowns patients face in the process of receiving their care, and coping behaviors they create to better handle information breakdowns and understand their care situation. This research is intended to inform designs for future health IT systems that can directly serve patient information needs during clinical stays and improve their overall experience through better information access. This work further provides empirical understandings of patients' adaptation to the sociotechnical environment through their proactive individual efforts.

## **Background**

### **Significance of Patient's Access to Information in Clinical Environment**

EHRs are increasingly comprehensive, and as a vast repository of information, they have already contributed to providers' work efficiency and hospital procedure by providing greater accesses and standardization. Nevertheless, the healthcare information stored in EHRs is

typically not accessible to patients, since these health IT systems were originally designed for clinical use, and this one-sided setup leaves patients out of its scope. In addition, many of the unintended consequences brought on by recent health IT system implementations exacerbate the patient's lack of information access in clinical settings. The negative impacts of health IT implementation include increased documentation time (Poissant et al. 2005), incompatibility with clinical workflow (Heath and Luff 1996; Cyert and March 1963), and more interruptions in medical work (Richardson and Ash 2008); these impacts often affect the quality of patient-provider interactions during a patient's hospital stay. My earlier study on the EHR deployment has shown that providers' increased documentation workload takes away from physical interactions between provider and patient, and that patients often experience more interruptions during clinical consultation due to providers' technologies usage (Park, Lee, and Chen 2012).

Nevertheless, patients, too, have the need and desire to access their health information throughout their care process. Researchers have shown, for example, that patients who were given more information during a visit to an emergency room, in particular, information about what to expect next, rated their hospital experience significantly higher than those who did not have access to this information (Björvell and Stieg 1991; Wilcox, Lu, et al. 2010). The benefits of providing patients with access to their health information have been well-recognized in many studies. The benefits of accessing more information during hospital stays include increased patient participation in decision-making about their care, reduced conflicts in decision-making, and increased adherence to care (Kaplan et al. 1995; Greenfield et al. 1988; L. Wilcox, Lu, et al. 2010). Studies also show that patients who are actively engaged in their own care often enjoy

greater satisfaction with their care, and a greater understanding of it, as well as improved health outcomes, such as better controlled disease management, faster recovery and healthy behaviors (P. C. Tang and Newcomb 1998; Street and Millay 2001).

Despite the patient need for obtaining information during ongoing care, only a few studies have examined how technologies can facilitate the access and use of information during the patient care process. Examples of the systems designed for patient information access and use during ongoing care are *OpenNote*, which enables patients to access and read their doctor's notes in between their clinical visits (Delbanco et al. 2001); the Patient Clinical Information System (PatCIS), which allows patients to review and contribute information to their electronic records via the web, by letting them add health-related information on their own (Cimino, Patel, and Kushniruk 2002); and information kiosks in waiting areas that were developed to help patients browse through their health information before their clinical consultation (Goldschmidt and Goodrich 2004). Bickmore and his research group studied the moment of patient discharge and found that patients' low health literacy and their lack of empowerment could be greatly improved through the use of a *virtual nursing agent* – an automated system used for educating inpatients on their post- discharge self-care regimen (Bickmore, Pfeifer, and Jack 2009). A series of Microsoft Research studies by Wilcox and her colleagues also emphasized the need for patients to have access to their clinical information in the care process, exploring different information display tools. Their earlier works looked at providing real-time information specifically related to medications (Wilcox et al. 2010; L. Wilcox et al. 2011; Wilcox et al. 2012); Pfeifer Vardoulakis et al. 2012), and also studied different ways of providing real-time clinical information, such as using a wall display in a patient room (L. Wilcox, Lu, et al. 2010),

tablets (L. Wilcox et al. 2012), and patients' mobile phones (Pfeifer Vardoulakis et al. 2012). In addition, these studies also examined providers' attitudes toward patients accessing information (e.g. how much information to share and how to share it) and the best presentation for such information, including the properties of a good explanation.

While these prior works show the significance and consequences of patients' lack of information access, the design of technologies for patient information access during the care process still needs far more research attention. Researchers have yet to achieve holistic understandings regarding the overall patient care courses and sufficient details of care practices; instead, they mostly focus on very specific information needs at certain points in time, such as the moment of discharge or when giving medication instruction. Unlike prior research that has focused on evaluating and suggesting different technological solutions, this study investigates what information should be provided, how and when to provide it, and how this information can affect or support current patients' information work practices. Addressing these questions will help us devise new ways to support patients' needs in accessing, learning, and communicating personal health information during their clinical encounters. It will potentially enhance patients' ability to adapt to such environments and actively participate in their own care process.

## **Challenges in ED Care Practice**

My study on patient information practices is situated in the ED because of the ED's distinctive setting. In addition, since I have studied the impacts of the health IT systems on the clinical work in the ED, the ED setting makes it perfect to examine the counter effects of these

systems on the patient's side. The ED is one of the most urgent, time-critical care environments, as patients' visits to the ED concern acute medical matters. The primary goal of ED care is to promptly stabilize patients' medical problems and to make the decision to either discharge or admit them. In the former cases, patients are discharged, and they may see their primary care physicians or do home care themselves following the discharge instructions; in latter case, patients are admitted, and ED clinicians must choose the appropriate department for them to be transferred. The general ED care process consists of short patient care ranging from 1- 2 hours to 1-1.5 days. In addition, the ED deals with a wide variety of illnesses, ranging from simple care (e.g. for patients needing stitches or patients presenting with influenza) to more serious exams (e.g., patients requiring an MRI or a CT scan requiring a specialist diagnosis) and the treatment of life threatening injuries. With this wide spectrum of care, most patients in the ED are extremely anxious about all the uncertainties associated with their stays, such as fear of having pain and not knowing what will happen to them.

According to a survey conducted by the Center for Disease Control and Prevention (CDC.gov), one in five Americans report visiting an ED at least once in the past year. Many reports have questioned the ability of EDs in United States to handle the increasing demand of emergency services (Trzeciak and Rivers 2003). Corresponding with the increase in ED demand, many studies show that most patients are not satisfied with their overall ED care due to a variety of reasons, including ED overcrowding, quality of care, patients' low health literacy/language barrier, and the lack of communication between patients and their healthcare providers (Krishel and Baraff 1993; Boudreaux and O'Hea 2004). These studies suggest solutions for improving patient satisfaction, including reducing the perceived waiting times,

modifying ED processes through performance improvement methodologies, providing educational materials, and enhancing the quality of interpersonal interactions (Boudreaux and O’Hea 2004). Researchers have shown, for example, that patients who were given more information during a visit to an emergency room, particularly information about what to expect next, rated their hospital experience significantly higher than those who did not have access to this information while receiving care (L. Wilcox, Lu, et al. 2010).

In the ED, healthcare providers and patients experience an information imbalance due to the ED’s nature. ED’s time-pressured care with short patient turnaround time imposes heavy workloads upon providers. ED care providers often have to treat several patients in a row without having time to chart between patients. They are constantly called to perform time-sensitive coordination work to collaborate with other care team members. In addition, ED care teams are formed dynamically *in situ* upon the arrival of a patient by bringing together an ED nurse, the charge nurse, a resident, and an attending physician. Such teams can even include translators, technicians, admitting residents, and specialists. They are then disassembled upon a patient’s discharge or admission. This process differs from other care practices in which a single designated team takes care of the patient the entire time (Lee et al. 2012) and providers always know who is on each care team for each patient. Moreover, the use of a variety of information technologies, such as EHRs, diverts the time and attention of ED providers and staff away from communication with patients, by imposing certain workloads and workflows (Park and Chen 2012).

As a result, in contrast to providers, whose work constantly manages large amount of time- sensitive information with regard to multiple patients, team coordination and many



systems, patients in the ED often suffer from information deficiency – a lack of prompt updates and explanations about their ongoing care situation. They become heavily reliant on health providers to acquire information and make decisions during care. This great dependency on providers can further affect patients receiving timely information updates, and can even affect their quality of care. Patients may not be sufficiently informed to continue home care themselves or report to their primary care physicians after discharge, even though they are responsible for acquiring and understanding all the information garnered during ED visits. Therefore, finding an appropriate balance between two separate information environments – information wealth and information poverty – is significant in this highly complex ED environment. This is not to say that the ED workload or workflow is problematic due to the current system design, but patients should be taken into account in health IT system designs, rather than neglecting their needs and thereby aggravating the current information imbalance problem.

While there has been quite a bit of work in the HCI and Medical Informatics communities in developing technologies and techniques to support healthcare professionals in providing, tracking, and documenting information during clinical encounters, it is only recently that the patient has garnered direct attention. To the best of our knowledge, no study to date has examined patient information needs and information behaviors engaged in during the overall course of the patients' hospital stay, especially during ED stays where patients often experience extreme anxiety, stress, and uncertainty. In this work, I aim to gather situated empirical evidence of the needs, behaviors, perceptions, and attitudes toward patients' information access and their adaptation to the sociotechnical care context of the ED. I believe

this area is rich in investigating challenges for HCI, CSCW, and Medical Informatics work, and can provide great opportunities for technological interventions to improve patients' own participation and healthcare experiences through better information access and use.

## **Patient Care Trajectory and Process in the ED**

In this section, I first provide an overview of ED patient care, outlining different phases of the ED care process. Note that although patients' ED care may vary based on each patient's own situation, in this thesis I try to summarize the common phases based on key temporal events throughout the process. I then describe the current information delivery media available to ED patients, and the challenges involved in using these media.

### **Patient Care Trajectory**

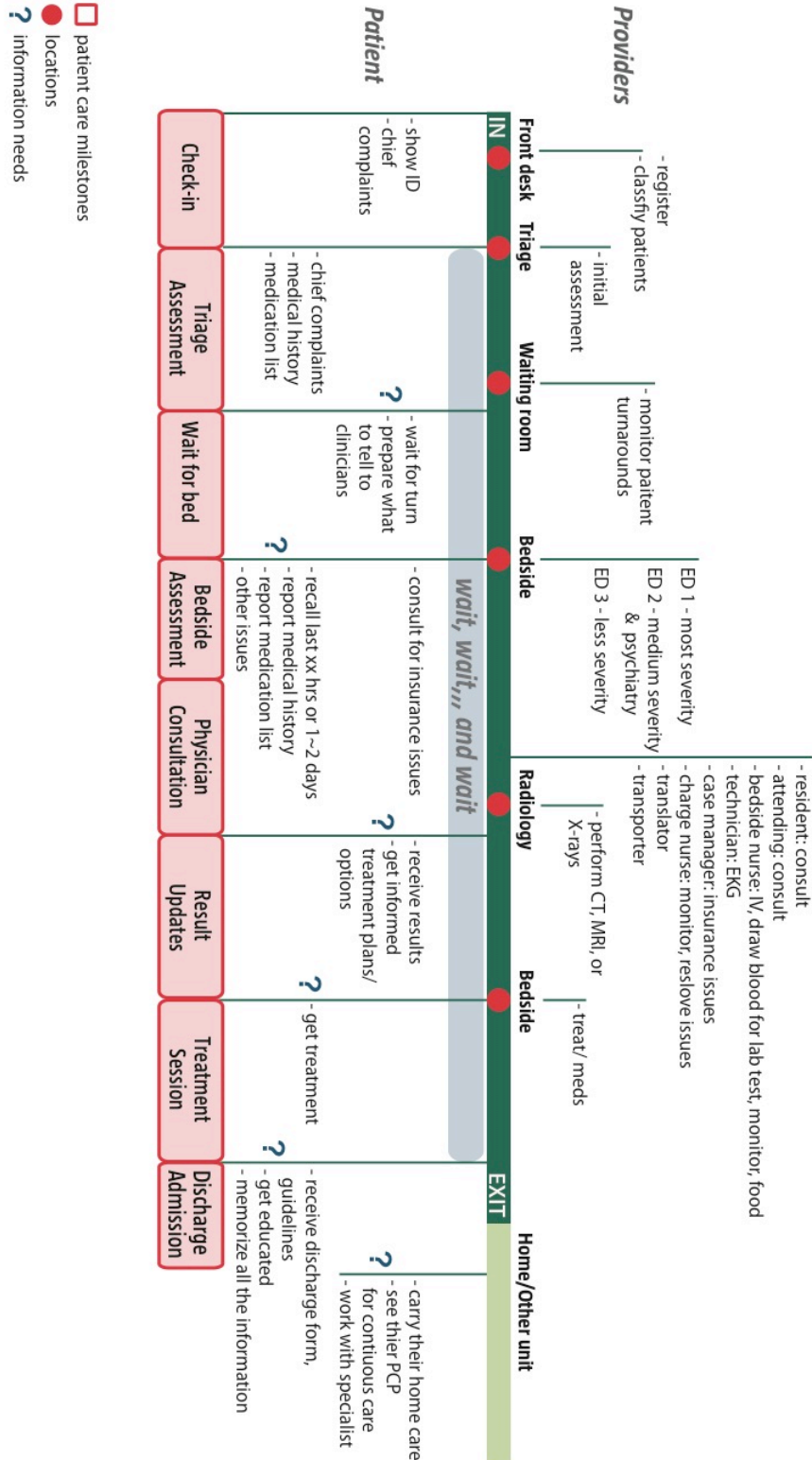
Trajectory is one of the important concepts drawn from medical sociology (Fagerhaugh and Strauss 1997). Strauss uses the term trajectory to describe the physiological unfolding of a disease process, along with the entire organization of work done over the course of the process, and the impact on the people doing this work. Over the course of a single trajectory, countless routines, artifacts, and rules are articulated in order to provide a course of treatment for a single patient. In this thesis, I use the notion of trajectories to describe the entirety of the coordination efforts and mechanisms that come into play in service of collective patient care work.

The ED patient care trajectory (Figure 5.1) consists of several distinct phases with different temporalities. These phases include the major touch-points<sup>1</sup> in the care process, where care activities and information delivery occur, and each phase marks a key progress of care. In my observation, the care trajectory comprised eight phases based on major events, ranging from a patient's arrival in the ED until the moment of his or her departure. Specifically, upon arrival at the ED, a patient registers at the front desk with staff and checks in with a triage coordinator who classifies patients based on the severity of the chief complaints motivating the ED visit (*Check-In*). The patient is then called in to triage for an initial assessment (*Triage Assessment*). In triage, the patient interacts with one to three nurses who ask questions, perform bloodwork, and conduct an EKG<sup>2</sup> exam. The patient is then sent back to the waiting room to wait until a bed is available (*Wait for Bed*). At the bedside, the patient meets a bedside nurse who conducts a more thorough assessment (*Bedside Assessment*); he/she then meets with a resident and attending physician for consultations (*Physician Consultations*). After ED physicians make a specific care plan, the patient undergoes different tests, such as radiology tests, or consults with specialists (*Result Updates*). Then, he or she receives the necessary treatment, such as medication or procedures (*Treatment Session*) and stays under observation until proper recovery. Once all the final results are back, providers decide whether the patient is stable enough to be released or needs to be sent to another unit in the hospital (*Discharge/Admission*). Some of this process, such

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<sup>1</sup> a *touch-point* describes the interface between patients and any moment of decision making (by interacting with a product, service, provider, or any other stakeholders) during their care process. The concept of touch-points is often used in the field of service design to describe a service-encounter, the point of contact between a service provider and customers (Clatworthy 2011).

<sup>2</sup> An electrocardiogram test that checks for problems with the electrical activity of the heart.



**Figure 5.1** An example of ED care trajectory:  
 Each red box indicates each phase in the care process. The activities of providers (top) and patients (down) are shown.

as result updates and treatment sessions, can be repetitive, since it may require additional tests or take a few rounds of treatments to get patients finalized.

Throughout this ED care journey, at each phase or in between phases, patients often had to wait for undefined periods of time, go through unfamiliar tests with unknown results, and undergo a treatment plan. Thus, as seen in the diagram (Figure 5.1), there were a lot of “waiting” periods and “question marks” indicating that patients may need more information at these moments.

### **Current Information Technologies & Media Use for Patients**

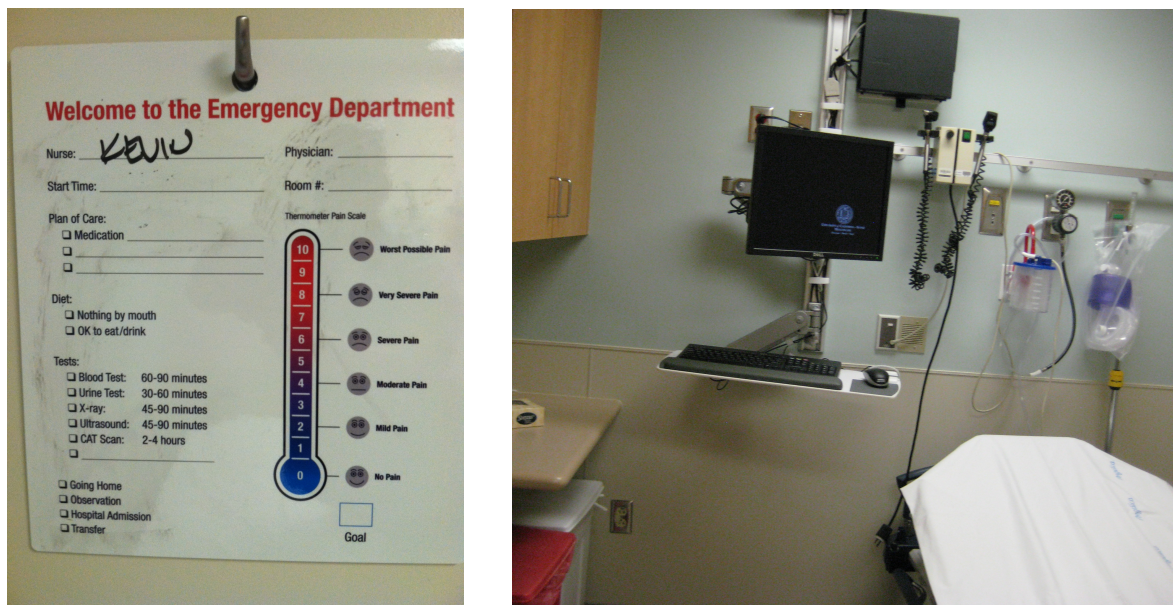
Although patients desire to know and be able to manage their health information during their care process, most of the existing information technologies available in the ED do not offer access to patients. The EHR system is the primary information repository and information source in the ED. The EHR is designed to serve as a comprehensive information infrastructure that serves as a key component of clinical workflow, offering functions such as charting, scheduling, entering orders, and retrieving results. All care providers and administrative personnel utilize it as their main tool to search, retrieve, document, save, and share patient medical information. This comprehensive information repository would seem to be an ideal system for patients to access information regarding their own health during hospital stays for its vast amount of patient health data stored, yet patients lack direct access to EHR data during their clinical encounters.

The current health IT systems, including EHRs, are usually designed to support the needs of healthcare providers in clinical environments. While the bedside computers mounted

on the wall support providers' easy access and the use of patient health information during clinical encounters, patients do not have ways to use them. Patients can only access their information during ongoing care through interactions with their healthcare providers; for example, getting verbal reports on care information from providers, glancing over the computer screen to see the medication list or x-ray images when providers use or show them, or receiving paper printouts for diagnosis or treatment information. At my field site, the primary channel of accessing and receiving information for ED patients is direct communication through face-to-face interactions. However, this approach is heavily dependent on providers' availabilities. When healthcare providers, especially physicians, are unavailable to provide clinical information due to their heavy and mobile workload, patients have to wait, or may request the needed information from nurses. However, even nurses are not always around or available due to their heavy workload of taking care of multiple patients. Nurses also generally do not initially provide clinical information, such as test results to patients unless directed to do so by physicians, because such information requires further clinical explanation.

In addition to verbal updates, another information delivery media for patients is the whiteboard and vital sign monitor installed in patients' rooms (Figure 5.2). These technologies were available at the bedsides; however, ED patients did not perceive any potential use or benefits in them because these information media did not meet the patients' needs. First, the vital signs monitors are touch screen monitors that continuously measure and display key information about a patient's condition, such as blood pressure, body temperature and heart rates. They were mounted on the wall above or next to the computer at patients' bedsides. Despite the real-time updating information about the patient's conditions, the information on

the vital sign monitors was not legible or meaningful for patients and caregivers, because many of them lacked medical knowledge or were not familiar with their own health conditions. Patients sometimes had a difficulty in looking up at the monitor since they were mounted too high to reach, especially when the patient was lying down on the bed with many wires surrounding them.



**Figure 5.2 Whiteboard (left), and the bedside computer for ED providers and vital sign monitor above in the patient room (right)**

Next, the whiteboard in the patient room was specifically designed to provide for patients their basic care information during an ED stay. Information on the whiteboard includes the names of nurses and physicians, room number, body temperature, care plan, and tests ordered/conducted. Despite their design for patient's benefits, the whiteboards were often found to be empty or to contain delayed information, because bedside nurses often forgot to or literally did not have enough time to update them. While the information on the vital sign

monitor was automatically updated, the bedside nurses were responsible for manually adding information on the whiteboard once patients were assigned to their beds, and keeping them updated during their patients' entire stays, which was not ideal or realistic for the ED nurses' work. None of the nurses, in fact, were fond of having a whiteboard at the bedside, nor did they find it useful. None of the nurses at our field site believed that the whiteboards were an appropriate system for ED practices. Compared to other units where a bedside nurse takes care of one or two patients throughout a day, ED nurses are too occupied with care work divided among multiple patients, and collaborative work with different physicians and other nurses, to repeatedly update the whiteboard information for patients. They viewed updating the whiteboard as another cognitive and logistical burden, adding unnecessary work to their workload. On many occasions, I observed that the names of previous patients were still on the bedside whiteboards. One of the nurses commented, *"ED whiteboard[s] is not very realistic. I've been here since 3 pm (it is 7:30pm now) and I've already seen 8 patients. Doctors keep changing, too. The status changes so fast that it is hard to manage updating the whiteboard."* Manually updating the whiteboard was challenging because of high patient turnarounds in the ED, frequent changes in patient care plans, and heavy nursing workloads. Consequently, almost none of the patients in our study found them useful, and many of them did not even recognize their existence.

## **Information Breakdowns and Patient Strategies**

While the work practices of ED providers are well-supported by health IT systems, current ED practice places a large burden on patients and caregivers as well. As mentioned



before, patients in the ED do not have access to information and the current systems (e.g., vital sign monitors and whiteboards) that can provide ongoing information are not easy for patients to use. At our field site, especially during busy times in the ED, patients and caregivers were often left without receiving timely information. There was no support from information systems for them, and health providers were often too busy to attend to patients' health information needs. Thus, patients had to wait for providers, and wait for tests results; patients did not know who was in charge of their care, what was holding up their care, or at what state in the care process they were at. To deal with the inefficiencies in accessing appropriate information and navigating the information-lacking environment, I found that patients and caregivers actively developed a variety of strategies during their ED stays. They deployed these strategies to prevent or better deal with all the breakdowns that might happen inside, as well as outside, the ED.

In this section, I report five basic information breakdowns extracted from my field study due to the patients' lack of information access in the ED: (1) lack of information sources, (2) information overload, (3) information delay, (4) information inconsistency, and (5) information unpredictability and contingency. I then describe a corresponding strategy developed by individual patients and caregivers to cope with the problem, such as identifying potential alternative sources, managing information overload, preventing information delay, maintaining information consistency, and planning for contingencies. These elucidate the typical breakdowns due to barriers in information availability/accessibility and the nature of ED care. I chose these five breakdowns and the corresponding strategies, since they represent common

information behaviors that patients and caregivers developed to cope with breakdowns and challenges.

In each case, I first outline why the information breakdown occurred. Second, I describe the strategies patients and caregivers developed to prevent negative consequences from resulting from the information breakdown.

## **1. The Lack of Information Sources**

The first type of information breakdown I observed was the issue of having no easy access to information sources. Soon after patients entered the ED, they found there were no information sources available to them other than the busy healthcare providers. This situation forced patients to actively seek out any information sources available to them such as finding approachable providers, or observing their physical and situational surroundings, such as the number of patients in the waiting room, to access information.

ED patients and caregivers had a common need to access information related to medical knowledge, care in progress, and care goals. Accessing and knowing this information is particularly important for them because most patients come to the ED with unexpected symptoms and must go through an unfamiliar care process, with an ED stay of an unforeseen duration. Nevertheless, despite these needs, information was usually not forthcoming; updates were not easily available to current ED patients, either because they did not have direct access to an information source, or because no information source was available to them. In outpatient clinics, patients can access their medical records through a patient-portal system in order to review their medical history, previous visits, medication visits, and test results, and this portal

can be used for communicating with their individual care providers (Sun et al. 2013). In ED care, I observed that there was no efficient way for patients to access their own healthcare information during ongoing care, unless they asked care members.

Receiving information directly from healthcare providers was the most typical way for patients to access and learn about their care because no other information source was available for use. However, patients usually found it difficult to find opportunities to interact with their healthcare providers, who were usually occupied with other care work in the ED. As a result, patients commonly remained uninformed and were not able to actively engaged in their care process. One caregivers, who was a family member of a patient, complained of the difficulty of finding their provider:

*"I barely saw the nurses. Actually, there were three nurses, a guy and two females. I guess shifts were over or something, and someone else came on. It was tough to flag down a nurse. We're in the little corner. I don't know if it was that little corner or...I had to go around and look for one instead to get... They were just not visible."*

While the information work of the providers was supported by a variety of health IT systems, there was no information system to facilitate patient access to care information. The systems in the patient rooms and bedsides, such as the vital sign monitors and whiteboards were not really useful for patients as seen earlier. The vital signs monitor was not easy for patient to access and it also required certain medical knowledge for patients to interpret. The whiteboard at the bedsides was the only current media intended for patients to receive information; however, the whiteboards were not used much at our field site because they included only a very limited amount of information, such as the bed number, bedside nurse's

name, and vital signs. This was not sufficient to support the diverse information needs a patient has (as we have identified in the previous section). In addition, it was also too time-consuming for the bedside nurses to update the whiteboards regularly due to their high volume of fast-paced and often urgent clinical tasks.

### *Strategy to identify alternative information source*

To cope with the problem of accessing information, patients and caregivers deployed different strategies. First, they actively reached out to any available healthcare provider by walking by the nursing station or moving around in the hallway. The most commonly requested information I observed concerned the current situation and any upcoming care steps – “*What are we waiting for?*”, “*Why do we have to wait this long?*”, “*How long do we have to wait?*” and “*What’s next?*” Caregivers frequently approached any provider they saw to request additional information about care-in-progress while they were waiting at the patient’s bedside. Family members, in particular, who arrived late in the ED grabbed any care team member to request any up-to-date information since there was no information source or reference available for them.

The next coping strategy used for the lack of an information source was for patients and caregivers to observe their surroundings. Since there was no information source for patients to access and receive, particularly when the wait at the bedsides became very lengthy, and when no other providers were around, patients and caregivers had to use physical surroundings, such as vital signs monitors at bedsides, other patients in the ED, providers’ activities and availabilities, or sense the situations at the moment, like overhead paging about incoming

trauma patients, etc. Patients and caregivers utilized contextual clues in the surroundings as alternative information sources to figure out the current state of their own health condition, as well as the current status/situation in the ED to foresee the next step.

For example, in the waiting room, patients and caregivers often tried to figure out potential wait time to receive a physician consultation using alternative sources. They counted the number of patients in the waiting room, looked around at other patients to figure out the acuity of their care needs, or carefully listened to overhead pagings about incoming trauma patients. This occurred to almost everyone I observed during in the study. Some caregivers and patients asked other caregivers and patients about how long they had waited in the waiting room. Patients and caregivers also found out information that was not specified or mentioned when entering the ED, such as registering their car in the ED parking lot, by observing other patients and caregivers registering their cars at the front desk. By doing this, patients anticipated how long they would have to wait and when they might be able to see a doctor, or even to decide whether they should stay in the ED or not.

Additionally, in the patient rooms, many patients and caregivers actively read and checked the numbers on the vital sign monitors to know their own current condition, and they often asked the bedside nurse if they saw any changes, although they did not really know the exact meaning of number values. This contextual information was helpful in knowing which provider might be available and when is the best time to approach the provider to obtain proper feedback.

In summary, the problem of having no sufficient information sources forced ED patients and caregivers to develop proactive strategies. Since care providers who were already occupied

physically and mentally could not meet their needs, patients and caregivers utilized contextual information to identify alternative information sources to do things such as find available providers and to decide when to approach the providers and to observe the contextual cues in their surroundings, in order to compensate for the inaccessibility of information during ED care.

## **2. Information Overload**

The second type of information breakdown was the difficulty of processing information due to the experience of receiving overwhelmingly amount of information without sufficient time to process it or having an explanation given. When too much information was given within a short period of a physician consultation, it presented a challenge for patients to process, comprehend and remember; consequently, patients had to make efforts to document, request physical records, and search relevant information on their own to process and manage such information.

Our findings showed that most patients and caregivers suffered from a lack of timely access to information and long bedside waiting times; then, when information was finally provided, the amount of information delivered and the ways it was delivered, often raised new problems for patients. They often received a lot of information all at once and were unable to fully understand and absorb that information. Having information delivered in the way they could process was important for ED patients who were experiencing high levels of stress and anxiety, yet needed to understand their medical condition in order to be involved in their care. Although providers were usually very careful about the type of information they provided, taking care not to frighten patients or subject them to stress, they were not necessarily good at

considering how to deliver that information appropriately for patients. Especially at busy times, when they had to see multiple patients in a row, providers sometimes poured out a torrent of difficult terminology at top speed, without taking the time to clarify or explain this information.

This was common at the end of the initial consultation when physicians usually communicated care plans by rapidly listing possible diagnoses, tests or procedures they planned to conduct. As a result, after the consultation, patients and caregivers were left out, feeling overwhelmed, but it was not easy for them to hold physicians back since they did not want to interrupt the physicians' busy work. It became even worse when several physicians were involved in a consultation, such as when a specialist came with his resident and medical students; patients were easily overwhelmed with all the information they talked over and had a hard time filtering what they heard to understand and remember. Thus, patients experienced the long and silent bedside wait times but then, experienced a period of information overload. This is demonstrated in the example that follows.

*An 18 year old patient, Lee [PT 35], was brought in by his parents after having black stools for two days. Lee had a chronic condition – he was deaf and suffered from cerebral palsy – so his parents were in charge of his care, directly communicating with providers and doing all the administrative work. They arrived in the ED around 11am. After 40 minutes, they were assigned a bed in the ED1 unit and waited for a doctor consultation. A few minutes later, a resident came for the medical screening by asking questions about his last admission, medical history, and symptoms to Lee's mom. In the middle of the resident's consultation, an attending physician joined and asked more specific questions on current symptoms, while discussing the case with the resident simultaneously. After asking several questions, at the end of the consultation, the attending discussed a plan with the mother, speaking at a very fast pace: **"he [Lee] may need a transfusion. We will do some IV and lab tests and then see the GI doc. He probably needs to be admitted again, but we will see. The***

*blood might probably have been from Tuesday and left out, or it may be new blood. Anyhow, we have to get rid of it. We will start with the rectal exam.” The doctor then ran out in the direction of the trauma room in response to an overhead page about two incoming trauma patients. The mother responded, “oh, okay...” and stood there with a puzzled expression. A minute later, a bedside nurse came in to start an IV on the patient, and the patient’s dad came back from getting snack.*

In the case above, even though the attending physician actually disclosed all the available information about Lee’s care plan, his mother was still not able to grasp it all, let alone remember everything that was verbally updated to her. There were simply too many items on the care plan list for a layperson to properly grasp within a few seconds. After the consultation, I saw that the mother persistently asked a bedside nurse about what kinds of tests they would do and what the next step would be. When her husband returned and asked what the doctor said, she was only able to briefly mention the chance of re-admission but not the other items the physician had mentioned. Even for a patient like Lee, whose family had been exposed to and prepared for frequent medical visits and were somewhat knowledgeable about general healthcare information, it was still challenging to handle the information overload during their ED visit.

In addition, apart from some of the chronic illness patients, a majority of the ED patients had a relatively low health literacy; thus, they needed information to be presented as clearly and easy as possible. During the interviews, I discovered that several patients did not even understand the names of the medical professionals, such as ophthalmologist (this could have been rephrased as eye-doctor/specialist), and had to guess or make assumptions along the way



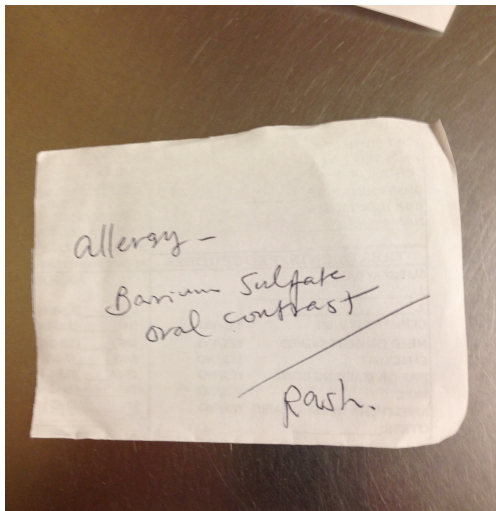
regarding their care; half of the patients could not remember the names of the diagnosis and the procedures they had.

### *Strategy to coping with information overload*

To address the information overload and to understand the unfamiliar terminologies, patients and caregivers developed a variety of strategies during their ED stays. First, patients tried to keep records of their care information by documenting and asking for printouts of images and lab results. Experienced chronic illness patients wanted to review the number values in test results and carry the records with them by actively asking for paper copies of any test results they had. Many patients and caregivers in our observations asked their bedside nurses to write down medication names or requested the treatment procedure details right after consulting with physicians in order to fill in the blanks and confirm the information they had received during their clinical consultation. Figure 5.3 was a memo written by a bedside nurse when one of the patients I observed requested writing the names of an allergy and the procedure the physician mentioned. By requesting and keeping records of their own, patients were able to not only gather the necessary information for themselves, but also to prepare appropriate questions or discuss any concerns with healthcare providers during ongoing ED care. This strategy was also beneficial for follow-up care after leaving the ED because patients could provide better ED information about their medical conditions.

Another strategy patients tried was to look up information, searching for visuals of physical symptoms to aid their own comprehension, normally through browsing their smart phones. For instance, a patient with an eye problem made notes on his smart phone based on a

potential diagnosis the physician mentioned during his consultation. He then looked for specific definitions of those medical terms related to his diagnosis while waiting in the room. This patient wanted to understand the meanings of these medical terms so that he could actually communicate better with the physician for the later consultation. Another patient, who had come to the ER the night before because of an insect sting, and came back again for the same, though not improved symptom, tried to process all the information he heard from the physician consultation. He first tried to look for relevant images of the area on his arm stung by a bee and to compare them with other images he found on the web, based on potential diagnoses the physician mentioned. He and his girlfriend then took several photos of his arm over a few hours to keep records of his symptom changes so that they could ask the physician about questions they could not understand and make sure to receive the proper treatment this time.



**Figure 5.3** A written memo that a patient requested to the bedside nurse to write about the names of allergy and procedure information.

To summarize, experiencing information overload at certain information peak times was another type of information breakdown for patients and caregivers, hindering their understanding, as well as their engagement in ED care. To deal with this breakdown during a very short ED clinical consultation, our findings showed that patients made progressive efforts

to adapt their behaviors by developing strategies for documenting, keeping records, and searching for relevant information. These strategies were not only beneficial for patients by helping them actively engage in their ED care by recording, keeping, and managing their own care information, but also valuable for their own health as once they were more able to understand and follow care instructions, they were more able to prevent themselves from re-admittance to the ED.

### **3. Information Delay**

Similar to dealing with a lack of proper information sources, patients and caregivers also suffered from delays in receiving information. Long waits without getting any timely information updates made patients and caregivers develop strategies, such as reporting care activity-related information to providers and repeatedly reminding providers of their wait for updates, in order to trigger information delivery and accelerate their care process.

Resonating with numerous ED studies, delayed information delivery was one of the prevalent breakdowns in my field site. Delays in receiving information induced lengthy wait times, increased patients' anxiety and stress, and even led to information failure or loss in- the middle of delivery to patients. Information delays were caused by multiple factors related to ED work processes. First, the nature of ED providers' work is very impromptu and must respond to emergent situations, instead of being pre-organized. Compared to other typical care settings where providers take care of the patients with whom they have been scheduled for the day, the ED deals with patients whose conditions span different levels of severity and urgency of care. Depending on the cases and the numbers of incoming patients, the care priorities for providers

can be altered at any minute. As a result, providers, physicians in particular, can be caught up in caring for trauma patients for hours before giving proper attention to other patients. Even when an update on a test came in on the EHR system for a patient, physicians still may not be notified since they were not able to stay on the system to check up on their patient list page. Similarly, bedside nurses can also be caught up with many urgent tasks in the patient room, though they usually check the system more frequently and sometimes remind physicians of new updates in order to avoid delays.

Second, another reason for information setbacks identified in my study was because of the fallout of temporal dependency in the collaborative ED care process. As described earlier, a patient care trajectory consists of multiple phases requiring sequential execution. The activities performed at any phase are temporally dependent on the previous phase. Specifically, clinical updates can only be given to patients after successfully going through the preceding order execution phase, since information only becomes available after the execution of prior care activities. At times, this may require orders or care tasks to be completed by other departments, which can also cause delays due to workloads in other departments. In my fieldwork, I observed many other cases where ED providers had to make a pause, waiting for a consultation from admitting residents, for pharmacy approval, for bed availability inpatient units, etc. Waiting between different care phases produced stress and anxiety for patients and caregivers. One episode during our observation illustrates how the lag caused by delayed communication between the ED and other department could affect a patient's stress, as well as treatment process.

*Bobby, a 44-year-old patient, suffering from a severe headache, was brought into the ED by his neurosurgeon for his high blood pressure. After consulting with a resident at his bedside, Bobby was left to wait for hours in intense pain without getting any treatment, even after asking for pain medication a few times. In fact, ED physicians could not give him any medication, or perform any care tasks, for Bobby until they contacted his neurosurgeon due to ED protocols for referred patients. However, there was difficulty locating Bobby's neurosurgeon due to a team shift schedule and communication problems within the neurosurgical department. Since ED physicians had to hold up all orders, including medication and food, Bobby remained in miserable pain four hours, without any information regarding the reasons for the delay or his specific care plans. When an ED physician finally placed an order for a pain medication, a bedside nurse came to let him know his medication order status, along with its protocol, i.e. the requirement of not letting him drive home by himself after/with this med. Bobby realized that he could only get a ride from a friend whose work would not end for several hours, so he decided to give up the med rather than wait for a ride all night in the ED.*

This case illustrates two successive accidents of information delay: the lag caused by a delayed communication between the ED and the neuro-surgical department that eventually induced the delay in notifying the patient about an important medication protocol. In this case, the bedside nurse could have provided a heads-up to the patient about the protocol, but she might not have known what kind of prescription the patient would get, or might have been caught up with other care tasks while waiting for the physician's order, which did not allow her to act proactively.

When information delivery was delayed, it made patients unhappy and feel that they would never receive information updates or the providers were not helpful. In my interviews, many patients described how having delayed information could have negative impacts on their

care and their experiences in their ED stay. A patient with a severe headache expressed her frustration with waiting for timely feedback and information from her providers, *“To be honest, I can’t even really remember [what information I was asking]. When I asked the question to a doctor or technician there, I never got a straight answer. I got, “Well, let me go ask” and then they never came back with an answer.”* Due to the extremely lengthy wait, the delay of information made her almost feel like she never got answers. Hence, an information delay can aggravate a patient’s lengthy wait and cause frustration, but more seriously, can cause an unexpected care treatment change, which can directly affect a patient’s health and health care quality.

### ***Strategy to prevent information delays***

In order to cope with the information delays associated with unexplained waiting times, patients and caregivers developed various strategies, such as approaching their providers proactively to check upon information updates, reporting their current health status to keep information updated without delays, as well as reminding providers of their wait for information, so that they could make sure their providers were aware of their need to receive updated information. Since patients felt that ED care providers always seemed to be caught up with other care tasks, patients made efforts to proactively follow up with their bedside nurses for updated information on their care process, e.g., whether the lab results were back or not; when they could expect to hear updates about the next procedure. In our observations, we saw Yasmine, a patient who waited more than five hours just to receive a medication, attempt to reach out to her providers in order to remind them that she had been waiting for hours.

*Yasmine, a female patient came in the ED for her eye infection. After having multiple clinical consultations and examinations with ED clinicians and an ophthalmologist, she was finally informed that she would be discharged soon, once she took the prescribed medication. After that, Yasmine had to wait for the medication for a couple of hours in the eye-exam room, and then, she was asked to leave since another patient needed the exam room, and she was in the process of discharge anyway. However, her lengthy wait for the medication continued even in the waiting room. Yasmine started worrying that her care team members might have forgotten her, as there were more trauma patients coming in the ED. So, she decided to approach to any available ED staff member to remind her previous bedside nurse of her wait for the medication and the situation of being discharged. After a while, Yasmine finally received information that her medication had to be compounded by the pharmacy, which was more time-consuming than simply getting it from the shelf. It turned out that the bedside nurse, who was occupied with several incoming patients, did not receive this information from the resident, who was also busy with multiple trauma patients, until Yasmine asked for it. Yasmine had to wait another hour in the waiting room for her medication, but with less irritation and worry, now that she knew the reason why she was being made to wait. Later on, the bedside nurse came out to the waiting room with the medication and care instructions. Then, Yasmine left the ED.*

As seen in this example, Yasmine's strategy of approaching and reminding her healthcare providers helped her receiving information regarding her ongoing care process sooner and released her anxiety of not getting proper treatment and recognition from her providers. During the interview, she said,

*"Well, the most frustrating thing for me was just waiting for the medication. You usually think that they already have it [med] there but I guess they didn't. So, I didn't think it was going to take like four or five hours just to get it [med]...that took really, really, really long, and when she [the bedside nurse] took that long I actually thought she just forgot about me because it took quite like three hours. Like I was waiting there I got really frustrated...she*

*wasn't hurrying up at all. So, I did walk along and I was trying to look for anybody to see what was going on."*

Our observations showed many patients and caregivers tried to proactively report all the events related to their care (e.g., empty IV bag or malfunction of medical equipment) by checking their own condition changes as much as they could while waiting. Patients believed they would receive updated information from their providers by constantly feeding their providers timely information and making their existence more visible in the face of their busy workload.

In order to adapt to the ED care environment where information was not updated or delivered in a timely manner, patients and caregivers developed and tried out several strategies to facilitate their awareness of their ongoing care situation. The strategies patients and caregivers used – such as reporting their current status to providers and reminding providers of their wait and need for their next care process – emerged from their proactive efforts to improve their own care. They actively tried out different approaches until they finally obtained the information they needed. More importantly, these strategies helped expedite patient care processes by keeping providers' attention on track; otherwise, the process would have been slowed down.

#### **4. Information Inconsistency Among Multiple Care Team Members**

The fourth type of information breakdown I found in the study was the problem of having multiple providers with inconsistent information updates because of their complex workflows and tasks. Interacting with different incoming providers at bedsides, patients and



caregivers realized there was some inconsistency in the information each provider provided. Since this inconsistent information could affect their care negatively, patients constantly made efforts to utilize different strategies to help facilitate the information-sharing among care team members, by deliberately monitoring providers' activities and repeatedly asking each provider the same questions.

In the ED, patients and caregivers have to interact with multiple healthcare providers, care team members who come and go in the different phases of the care process (Figure 5.4). These care team members serve as different information sources for patients and caregivers, since there is no proper information access point or system available for patients, as discussed previously. However, when communicating information at the bedside, patients and caregivers sometimes found gaps in the information that team members had. Because of the number of team members and the complexity of each member's tasks, it was challenging for every member to be on the same page all the time and inconsistent information frequently occurred. This is different from other care settings where a patient interacts with a few designated care team members during a clinical visit or a hospital stay. ED patients often deal with a care team comprising of as many as 10 providers, from core members to more peripheral members. Each member in the team serves different roles in different phases in the patient care process, and is also frequently changed during shift changes. Thus, it was not easy for team members to always hold updated information about each patient or to be aware of each other's work status.

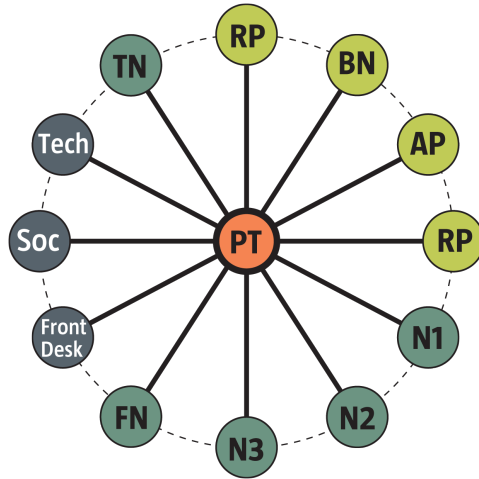
Despite the necessity of having every provider be updated all the time on every patient for efficient patient care, an information inconsistency frequently occurred because of a couple of factors in the actual ED work practice. First, with heavy and dynamic workflows, ED care

team members did not have sufficient time to check with the EHR or have a chance to meet and verbally update each other. ED physicians, in particular, could not have all the information up to date for every patient case and enter it into the EHR on a timely manner because they had to watch out for critical patients or incoming trauma patient. Thus, the EHR did not always contain the most up-to-date information, even though it is supposed to have a real-time information-feed for other team members. In addition, bedside nurses were not able to give proper verbal updates to other nurses, such as float nurses who assist with any task as needed, since they were too busy juggling multiple tasks. One of our interviewees, who came in the ED for a migraine, but had a history of kidney failure, explained a miscommunication she experienced among multiple healthcare providers during her care.

*"I know the third nurse talked to the doctor that admitted me because he gave her the order for the medicines. But I do not think the first nurse communicated with the doctor because if she did, she wouldn't have been trying to give me IV fluids, knowing I'm a kidney patient. I think she was just going in the mode, hooking everybody up to fluids and stuff. [...] I stepped in and I said, "Don't, because if I get fluids, I get sick. I get really, really sick, and I can't breathe." Because fluids will not leave me. They will stay in my body, and I will blow up like a fish. I don't think she communicated at all, or she would've known not to do that."*

In this case, besides the core care members, there were additional nurses working at the bedside simultaneously – one main bedside nurse and two floats who came in in the middle of care to assist the main nurse at the bedside. The patient perceived an information gap in the communication amongst these multiple nurses – a gap that ran contrary to the expectation that care team providers share all detailed information updates in a timely manner. The information gap among the providers about her medical history caused this patient to consider that her ED

providers might not be communicating appropriately or effectively amongst themselves, making her become concerned about the quality of her care.



**Figure 5.4** Various care team members involved in one ED patient case. Light green indicates the core care team members (e.g., Resident Physician, Bedside Nurse, and Attending Physician). The others are peripheral members (e.g., a triage nurse, float nurses, several nurses including charge nurse or next shift nurse, technicians/radiologists, social worker, etc)

In addition, the EHR does not contain every piece of information about a patient; some information was beyond what was documented in the EHR. Certain information, such as psycho-social information, was not easily shared within the EHR system, but mostly communicated verbally among care team members. Psycho-social information is information regarding a patient’s social and emotional state, which is somewhat subjective information from the perspective of providers (often bedside nurses). This information helps other care team members obtain a better understanding of how a patient has been doing in the ED in order to prepare how to interact with the patient accordingly. Thus, unless a provider has been informed of any pertinent psycho-social information by other team members prior to interacting with a patient, they may not have this information about the patient and interact with them in a

manner that upset them. Peripheral care team members in particular often do not receive this information unless they were informed by the bedside nurse in advance before entering a patient room. Some patients that might need to be dealt with in a more sensitive and gentle manner include those in extreme stress or in a lot of pain, or those who have experienced a prolonged wait, were brought to the ED for physical abuse or violence, or are younger female patients needing to share sensitive information.

### *Strategy to maintain information consistency*

Once patients and caregivers recognized the discrepancies in information updates among care team members, they developed several coping strategies. First, most of the patients and caregivers I observed started monitoring all of the medical activities providers performed at the bedside. The patients and caregivers checked the labels on IV bags and names of medications. By carefully observing these care tasks, patients and caregivers became more attentive to the care process – what was going on and what had been done so far. Through close monitoring, they made sure all of the medical activities and tasks were to be done without any mistakes.

Second, patients and caregivers tried to request and collect all relevant care information, and proactively pass along such information to each incoming provider, thereby hoping to avoid any information inconsistency among team members. This information ranged from the names of medications, the names of tests were being ordered, results, documents they received, and even care activities they observed at the bedside. Sometimes, before providers performed the tasks, they requested detailed information to the healthcare providers, such as what drug

was being given, why they were getting an IV, and what it would do to them. By proactively passing along the information they collected among different healthcare providers, patients and caregivers helped to maintain information consistency among care team members.

Later on, many of the patients and caregivers purposely asked the same questions to each incoming provider as a way of finding out whether a provider carried the same understanding about their care plan. They often asked questions, such as “*what is next after this [procedure]?*” or “*what [medication] are you giving me?*” When patients found discrepant information, they actively reported such information to the providers, especially to their bedside nurse or resident. The strategy of using repeated questions was perceived to be very useful because it allowed them to discover the inconsistent information, if there was any, as well as to make sure multiple providers remained on track. This information strategy also allowed patients to gain a more comprehensive picture of their care, since different care team members could contribute different levels of detail in the information they conveyed to the patient.

A following vignette from my observation illustrates one caregiver proactively check and provide information updates regarding his father-in-law’s care plan to incoming care team members in order to eliminate any inefficiencies.

*At 1:45pm, a 68 year old male patient came in to the ED with his son-in-law, as his caregiver. He came into the ED, referred by his cardiologist, because his routine blood work in that morning came out to be high potassium for the hyperkalemia. He had other symptoms like 8 days of diarrhea and vertigo. He had a past history of congestive heart failure, hypertension, and high cholesterol. Since the patient was old and did not speak fluent English, his son-in-law, Paul, was communicating with healthcare providers. After getting*

assigned a bed, the patient went through different tests, such as lab and EKG, and had to wait a couple of hours for the results. Up to that point, Paul had interacted with three different nurses (bedside nurse and two float nurses), two technicians, a resident and an attending physician. After more than a two hour wait, a resident came to the room to inform Paul that they would keep the patient in the hospital overnight and consider admission since his potassium level was still too high for unknown reasons, and left the room. After 10 min, two float nurses came in to the room with medications and fluids.

**Paul: (scanning what nurses were bringing with) Are you giving him [a med name]?**

**Float nurse:** Yes, we are going to give him [the med name] that will make him want to poop. He will mostly have to go alone if none of us are around. So we will give you meds. You [the patient] have to drink it... and then will give some fluids too.

**Paul: What about after that?**

**Float nurse:** I am not sure... I will have to speak to the doctor about it.

**Paul:** I think they're admitting him. I just spoke to the doctor. He will be admitted.

**Float nurse:** Oh, all right.

Float nurse left the room to check with the bedside nurse and the EHR system to see if there's any new order based on the decision made for his admission, and the other float nurse carried on the task in the patient room.

As seen above, the caregiver, Paul, actively monitored the incoming providers' activities and requested information about what they would do to the patient and what the next step would be. Doing so he could make sure that not only was he receiving information updates from providers, but also ensuring each provider had the same information update regarding the care procedure and plan. In this case, the admitting decision was made but not updated in the system, thus the float nurse was not yet notified. When Paul asked the float nurse about the next step ("what about after that?"), this information was already given to him by two other

providers, but he wanted to check up and keep the float nurse updated if needed and prevent any potential mistakes.

In responding to information discrepancy among multiple ED care team members, patients and caregivers gradually developed and refined their information strategies, such as deliberately checking up on all incoming care members by asking them the same questions in order to maintain the shared information amongst providers. These strategies enabled patients and caregivers to monitor their own care and ensure its quality by addressing potential concerns arising from information gaps among multiple care members, and helping them facilitate care team members' information-sharing and overall level of awareness. Of course, since not all the patients and caregivers were as active as Paul, there were patients studied in this work who did not engage with these proactive strategies or did not even notice the information gap. In this case, the risk of having breakdowns was higher, unless any care team member noticed during the patient's care. During my observations, a couple of patients had to return to the ED for the same symptom the following day.

## **5. Information Unpredictability and Contingencies**

The last type of information breakdown identified in the study was caused by the unpredictability of ED care. As described in earlier sections, in the ED, patients and caregivers experienced unpredictability in their care plan because of the nature of emergency care, resulting from such factors as time constraints, uncertainty, interruptions, and overcrowding. The unpredictable nature of the care environment in the ED was not favorable for patients and caregivers, who had an essential need to know their specific care plan and were already under

stress. Thus, not knowing what to expect and dealing with unforeseen changes in their care were big challenges for patients and caregivers. The unpredictable nature of ED care is different from other typical care settings where patients are already aware of the reason for their visits and are informed of their treatment plans in advance.

We observed that the contingencies and uncertainties were introduced by various factors at various care phases, depending on the situation in the ED. Uncertainty arose in the form of changes in the care plan due to unexpected test results, such as discovering a new disease or the need for urgent spinal surgery. Things such as these dramatically affected patients' plans for medical care, as well as their personal lives, as they had to make quick, but critical decisions in a short period of time. Uncertainty also appeared when there were changes due to an unknown wait time or other situations in the ED, such as a staff shortage, multiple trauma patients coming in, or other external factors, like delays at the pharmacy, a lack of available beds in the hospital, etc. Oftentimes, even when patients knew they would be admitted, the wait for a bed in the hospital was one of the unknown issues. Patients would not know how long they would actually be waiting for an available bed, which could range from a couple of hours up to three days.

A case below from our field observations shows how difficult it was for a patient and his caregiver to deal with an unexpected, almost life-changing event that occurred during an ED stay, which they never could have imagined when coming into the ED.

*At 7:30am, a 46 year-old male patient, Tom, came in to the ED with his girlfriend for severe pain in his upper back and bilateral hip. He explained to the triage nurse that his pain was there all the time, but it had become worse for last three days, and then, the previous night it had reached the point where he could not even move at all, so they decided to come in the ED*



*in the early morning. Since there were not many patients in the ED, Tom went through the ED care process without much wait time. After an X-ray and MRI test, a spine surgeon came into the room and informed him that the image results required an urgent surgical procedure, called thoracic decompression, and a possibility of a spine surgery. The surgeon provided critical information to Tom and his girlfriend, including the reason for the pain and symptoms, the necessity and purpose of surgery, the surgery process, possible results, and complication possibilities, by showing them his X-ray and MRI results. In between his explaining, Tom asked questions like, "Would I be up again?", "Would I be able to walk like now?" In the middle of the surgeon's explanation, Tom burst out crying and asked him to leave and give him some alone time. The surgeon tried to console and persuade him to get the surgical treatment by informing him of the importance of the timing and treatment, and let him know he would prepare the procedure for early tomorrow morning.*

As illustrated in Tom's case above, a contingency during an ED stay could happen as a sudden, extremely unexpected event that could possibly change a life entirely. During an informal conversation with Tom, he mentioned that he never thought about the possibility of getting admitted to the hospital when entering the ED that morning. Prior to his consultation with the surgeon, he only had worried about whether he could make it to work or not that night after taking a strong pain killer, since he worked as a club bouncer. After receiving the shocking diagnosis, Tom and his girlfriend had to start thinking about different plans. First, he had to find resources – not just finding a person to get a ride home from later, but find out information about his insurance plan and coverage to make appropriate decisions on his medical procedure and surgery. Next, he needed to find other resources to cover his job responsibilities since this unexpected event would affect his job significantly, as well. Then, he needed to plan for other things, such as preparing for his hospital admission and a longer hospital stay. He also needed

to talk to his family members since they were waiting to hear back about what was going on in the ED.

In addition, there are other contingencies observed during my fieldwork. For instance, some female patients had to coordinate the execution of daily chores like picking up, feeding, and taking care of children the same evening; other patients had to determine who could cover their work duties and who could give them a ride to return home later when discharged; and some caregivers who came with elderly patients had to continuously update several family members to divide up and plan caregiving work for the next two or three days. Thus, dealing with contingencies in the ED not only has a significant impact on the comfort and stress levels of the patients and caregivers, but also requires planning, with tasks ranging from careful decisions regarding the patient's health and treatments to making arrangements about daily chores.

### *Strategy to prepare contingencies*

In order to cope in the face of unpredictability and difficult contingencies, patients and caregivers made unceasing efforts to anticipate and make plans. From early on in the care process, patients and caregivers developed questions for providers to be prepared about what could possibly happen, so that they could make the dynamic nature of the ED visit more predictable, and minimize the impact of any possible contingencies. While physicians generally tend to provide very limited information on the initial elements (e.g., starting with IV and pain medication) of the care plan as it might change depending on the situation, patients and caregivers still tried to acquire any piece of information that could potentially help them narrow

down and predict their care as early as possible. For instance, during the initial clinical consultation or even at triage, they utilized questions – such as *“Am I staying over night here?”* *“What is the possibility of getting admitted?”* *“If she [patient] is admitted, which department is she going?”* *“Is that [the admitting department] located in the same building?”* *“If the test is positive or negative, then what do we do?”* *“Can she be admitted here?”* Through these probed questions, they tried to find ways to predict the possible direction of their care trajectory, as well as adjust their expectations accordingly. This, using probed questions, helped relieve patients’ stress and nervousness about the uncertainty they faced, and also aided them to improve their care quality, since they could better prepare their mental condition for potential tests, surgeries, and admission.

Next, based on their conclusions, majority of the patients and caregivers tried to prepare multiple alternative scenarios to better handle unexpected incidents and changes in the care plans. In doing so, they consistently approached healthcare providers, as well as communicated with people in their social circle outside of the ED, to find proper resources to assist with the emergent situation. This was shown in the case of the ED patient, Tom, who had to look for information not only about his insurance and medical procedures/ treatment, but also among his social network for information about people who could help with his job, as well as his hospital stay. Then there is the case of Diana, a heart-disease patient who came into the ED for chest pain, and because of the abnormal test results from her first two EKG tests, a decision to admit her into the inpatient unit was made early on. However, during the long wait time in the ED for her admission, Diana found herself that there was no bed available in the cardiac unit and no cardiology specialist is currently working in the ED. Knowing these, she started working

on alternative plans through communication with her family. An interview quote from Diana describes why she did this.

*“I’d learn there was no a cardiologist. I would have been happier even if there were a cardiology nurse, or a nurse practitioner, somebody who’d had some experience with cardiology, and there wasn’t. I asked several times [to the ED providers]. My assumption was that he [ED attending] was going from looking at the results of the various tests to make his decisions, but those two things, my not having seen this doctor and not to have had any kind of a cardiology person, worried me so much. Then being released, I was so tired that I definitely wanted to go home, but I did have some anxiety about it. So, I made a follow-up. I’ll be seeing my cardiologist over at Gottschalk Center, which is part of the system.”*

Here, Diana prepared for her longer stay in the ED; she also considered leaving the ED at the same time, due to her fatigue and energy loss, especially after two nights in the ED. Then, at the same time, she tried to inform her cardiologist of the emergency situation and make a follow-up appointment as a back-up plan. In planning these, Diana continued asking the ED providers questions to see if there were any further changes, and kept in touch with her son, husband, and her own doctor to get help accordingly. Thus, with persistent planning and re-planning, patients tried to minimize the possible mental or physical burdens imposed on them by unpredictable care plan changes and contingencies during their ED stay.

In this case, the study revealed that uncertainties related to ED patient care plans required patients and caregivers to anticipate their likely care trajectory by constantly utilizing probed questions beginning in the early stages of the care process, and preparing for any changes in care plans by proactively making alternative plans. These strategies represent an effort to adjust to an uncertain, complex care environment in order to improve their ED stay, as

well as to reduce any possible impacts on their healthcare quality and personal life. Patients' actions to this effect notably accommodated ED clinical practices by enabling them to better understand and cooperate during the care process, and also advance the work of clinicians who might have overlooked patients' perspectives and their need to prepare for contingencies.

## **Discussion**

In this study, I found that ED patients have unmet information needs because of the limited, and often unavailable information sources, in the busy ED. To fulfill their information needs, most of the patients and caregivers at my field site developed different strategies to cope with the various types of information breakdowns they encountered during their visits. As discussed in the previous section, patients experienced breakdowns when information sources were not accessible to them; when too much information was provided to them all at once; when information updates were not delivered in a timely manner; and when information-related care planning was uncertain and constantly changing. To deal with these breakdowns, many patients and caregivers came up with the following coping mechanisms: they approached any available ED staff and/or observed contextual cues to access information; they constantly reported and reminded their providers of their wait and care conditions to receive timely updates; and they proactively performed guess-work and made alternative plans to better prepare for any contingencies. While initially, patients developed these strategies to accommodate their basic information needs during breakdowns, these patient strategies later

improved the overall care quality in the ED by expediting part of the ED care process, aiding providers' work, and potentially enhancing patient safety.

My study indicates that the development of these strategies is, in fact, adaptive behavior on the part of patients as they strive to adjust to the ED care context in which there is limited information support to address their needs. Patients developed these strategies by actively projecting and modifying their expectations and behaviors through their interactions with healthcare providers, monitoring situational surroundings in the ED, and communicating with others in their social network. This can be seen as similar to the ED providers' own adaptation practices where providers design workarounds to alleviate the breakdowns caused by the newly deployed health IT system.

In this section, I first discuss patients' adapting behaviors from a design practice perspective. I then discuss the underlying goals and design needs for patients' adaptation to the ED environment.

### **Patient Strategies as Proactive Adaptation**

I have described the ways in which the ED patients and caregivers suffered from various difficulties in accessing, receiving, understanding, and anticipating information during their ED stay. In the ED, health IT systems treat patients as passive user of consumer of care by limiting or overlooking patients' information needs. ED care providers pay less attention to the provision of quality time and direct interaction with patients and caregivers, focusing mostly on performing urgent care tasks, having technical skills to use systems more efficiently, and maintaining patient flow. Thus, rather than enabling patients to be engaged in their own care,

the current ED care environment mostly places patients in a very passive role, and imposes significant burdens in accessing and receiving proper information guidance and help.

However, my study has shown that instead of remaining passive in the care process, many ED patients are, in fact, active agents who constantly strive to obtain the needed information through creating various information strategies. When the new EHR system was designed to support providers' work practices by providing greater access to information, it left patients without much information support, and even aggravated this lack of information access for patients by keeping the ED providers busier than before. The various strategies patients created to better deal with potential or existing information breakdowns, can be thought of as a process of rethinking and devising new ways of accessing information through their own proactive engagement in the care process.

In the process of developing strategies to alleviate information breakdowns, the ED patients in our field study constantly tried to figure out ways to get care-related information, persistently anticipate possible contingencies, and ensure that they received the right care. This process is similar to *design thinking* – a method of meeting people's needs and desires by anticipating potential breakdowns and designing a solving mechanism to cope with them (Brown 2009; Simon 1996). *Design thinking* differs from other problem-solving mechanisms, which begin with thoroughly defining all the parameters of a problem in order to create a solution. *Design thinking* identifies and investigates both known and ambiguous aspects of the current situation in order to discover and open up alternative paths, which may lead to the goal.

As was evident in our study, patients and caregivers initially realized that the ED environment, as well as ED providers, did not properly support their need for obtaining timely

information. As a result, they attempted to identify any alternative resources, including any personnel available to them, overhead pagings, and contextual cues in the physical surroundings, and endeavored to learn how to use those resources (e.g., knowing who to turn to and where to ask). Patients then created artifacts or built their own problem-solving mechanisms. In one instance, in order to solve the issue of information overload, patients created their own paper memos or digital notes on their smart phones, or requested memos with specific medication names or terms hand-written by providers, or even paper printouts of test results to save for future reference. In another situation, to accommodate the unpredictable ED care plans, many patients would work on one problem-solving strategy, while concurrently looking for alternative paths to get to the solution. Diana, a chest pain patient, who was one of the earlier examples, was making plans for an appointment with her own cardiologist, while she was also actively preparing for hospital admission, i.e. persistently checking with ED care team members about status changes regarding her heart condition, hospital beds, and provider availability in the ED and cardiac departments. Based on her investigation of the situation, Diana considered alternative paths, prioritized, and planned them on her own, so that she could find the solution that would work best – between enduring a longer stay in the ED to see a cardiologist and making a follow-up care appointment with her own specialist, as it was in this case – to get the best quality of care and health outcome.

This process of actively seeking the best solution that patients and caregivers were engaged in can be considered design thinking – the process of identifying and understanding their current situation, identifying the best workable solutions they could find, and iteratively looking for alternative solutions until the goal is achieved (e.g., getting information or receiving



the right care). Although there was a discrepancy among different patients and caregivers depending on their education level and disease experience, most of the patients we studied were proactively engaged in finding solutions through design thinking during their ED stays, since there was no guarantee that they would receive consistent, timely updates from preoccupied providers, and they wanted to be released from the ED as soon as possible. This problem-solving behaviors through design thinking is an adaptation process where ED patients and caregivers are required to go beyond passively remaining uninformed during their care or waiting for providers, so that they find themselves proactively handling breakdowns and creating different solutions. This is essentially a process of adapting to the information-lacking, busy and interruptive care environment they encounter.

Patients and caregivers' active involvement in developing their own problem-solving strategies illustrates clearly the value of the user-driven design process. My study shows that these strategies are the result of proactive adaptation efforts; patients and caregivers participated in the design thinking and strove to work better within the ED care context, by showing they were in need of access to contextual information in real time. Just as providers have adapted to the sociotechnical work environment where the newly deployed health IT system forced them to design different workarounds, patients also have adapted to their own sociotechnical care environment where unavailable and inaccessible health information forced them to create their own coping strategies. This aspect raises an issue for those who undertake the design and implementation of sociotechnical systems necessary to patient care work in hospitals, such as EHRs. In this context, healthcare infrastructures, which are usually considered instruments for professionals and institutions, should be reconsidered as tools for

supporting a polycentric health system, where patients are considered producers, consumers, and managers of health information on a par with doctors, nurses, and health organizations during their care stay. Furthermore, it is crucial to acknowledge and understand patients' proactive adaptation through their own design-thinking activities when designing future sociotechnical systems that support the needs of multiple stakeholders, and when promoting patients' information awareness about the care process.

### **Adapting to ED Care Context and Healthcare Requirements**

The five strategies patients developed in my study demonstrate that there are two distinct underlying goals in the patient adaptation process – one is to *adapt to the ED care context* by bridging the explicit information breakdowns and meeting basic information needs, and the other is to *achieve high quality of care* by addressing safety and efficiency concerns specific to the healthcare practices. The former goal is the motivation of adaptation wherein patients attempt to alleviate the problems introduced by the ED-specific care context, such as the absence of information access, information overload, information delay, and the inflow of unpredictable information, and then attempt to meet their own information needs. The latter goal is the motivation created by needs and the characteristics of healthcare practices, and pertains to the patients' desire to address certain concerns and expectations, such as safety of their own care. These two goals exist in parallel and emerge as a form of adaptation for patients in this sociotechnical environment.

The primary aspect of adaptation in the ED care context is the patient's effort to fit into the complex care environment, and enable information breakdowns to be better handled and

prevented so that their information needs can be addressed. Patient perceptions of the complexities of the ED care context have been well examined in many studies, and include communication challenges due to the lack of prior acquaintance with care providers, the short duration of provider encounters, uncertainty, interruptions, frequent staff changes, and overcrowding (McCarthy, Ellison, et al. 2013; McCarthy et al. 2012; McCarthy, Buckley, et al. 2013). It is well-known that most ED patients struggle with being acknowledged, becoming involved, and having quality interactions with their providers. A study has shown that patients with non-urgent medical problems seem to struggle more, and to feel forced into situations in which they must strive to maintain their personal integrity by relinquishing the possibility of taking an active part in their own health process and by not demanding much attention from providers (in particular, nursing personnel) in order to maintain a good patient-provider relationship (Nydén, Petersson, and Nyström 2003). However, these prior studies offer a somewhat limited understanding of actual patient information practices, and offer no further observations on how patients currently deal with these perceived complexities in the real care context.

In my study, ED patients strived to adapt to the ED context quickly, despite being in a complex and intense environment. When adapting to it, patients immediately experienced several difficulties in receiving more timely updates and quality care. The examples presented – such as lack of information sources, information overload, information delay, inconsistent information, and uncertain information – all indicate the care context itself does not really help patients get what they need and does not support their basic information needs. Thus, in order to meet their own needs and bridge the difficulties and breakdowns of the ED environment,

patients began creating and deploying their own coping strategies. The various strategies patients create and use to better deal with existing or potential information breakdowns can be seen as the patient version of workarounds – a way of working around existing resources and actively striving to adapt to the ED care environment. Just as providers developed different workarounds to cope with the problems caused by the new EHR system and to adapt to the new work practices, patients, also attempting to adapt, had to understand and interpret the problem they encountered (e.g. information uncertainty), develop their own strategies in order to handle the problem (e.g. asking care team members in advance, and constantly monitoring the situation any change in care circumstances), and modify their behaviors, attitudes, and expectations (e.g. trying to be flexible and planning alternatives for any contingencies). These adaptation behaviors comprised the patients' individual endeavors to make their care information more available and accessible.

The other goal of patient adaptation was identified at my field site as addressing the healthcare goals, needs, and characteristics in the ED. As described in the previous chapter, in the providers' work practice, the organizational-level adaptation occurred at the management level, where ED providers were forced to alter their workflow to meet certain requirements of the healthcare organization, such as quality control and patient privacy. In a similar manner, the patients' adaptation behaviors, in which they created and deployed their own strategies to bridge various information breakdowns, also attempted to address certain needs or characteristics of the healthcare practice. Although patients developed their adaptation behaviors for their own care concerns, these behaviors were, at the same time, designed as a way of striving to sustain and meet specific healthcare goals and needs such as safety and

efficiency concerns required by the healthcare practice/organization. Thus, this goal is designed to cater to the specific needs of the healthcare practice on a broader level, whereas the previous adaptation goal was mainly to seek information and handle the information breakdowns brought about by the ED care context. These patient adaptations behaviors helped patients themselves to ensure and maintain their own safety and quality of care. Moreover, they further helped and facilitated ED providers' care work by avoiding potential medical errors, supporting care team awareness, and prompting for and expediting the next care process.

For instance, in the earlier case of multiple providers being involved in one patient's care, patients and caregivers recognized that different care team members involved in the same patient's care did not always carry consistent information updates when coming to the patient's bedside (e.g., not being aware of a specific history of kidney failure for the patient who came in for severe migraine, or not having timely updates on the patient's care plan), because of their complicated workflows and multiple patient care involvement. They realized that this information gap among team members could affect their clinical collaboration, possibly jeopardizing the safety of the patient's care. As a result, to maintain information consistency among care team members, as well as to address safety concerns, patients and caregivers wanted to actively monitor and update every bit of information between providers, and they asked providers questions to check up on their information consistency. This adaptation was developed by patients through learning to understand the healthcare practice and its specific needs – i.e. patient care is done by multiple care team members who are required to work collaboratively and efficiently, but it is challenging to have everyone updated in the actual practice – and modifying their own expectations and behaviors accordingly – i.e. bridging the

information gap by reporting and checking upon each provider about the most updated information, at least at the patient's bedside. Therefore, this second goal of addressing healthcare specific needs is devised on a higher level and with a broader perspective than the first; it reflects a concern for maintaining care quality, goals, and needs within the healthcare practice and organization, deploying the patients' own strategies to ensure their care safety, as well as to make the healthcare practice more reliable and efficient.

Based on my analysis of patients' adaptation practices in the ED, I argue that their adaptation process and motivations inform significant design opportunities for future health IT systems in hospitals.

1. *Designing a patient dashboard for patients' information needs:* One of the prominent observations from the study was that the adaptive behaviors developed by patients were used to accommodate the information breakdowns caused by the complexity of ED work practices. ED patients desired to have their own secure information source, which could be easily accessible and physically available nearby, provide information related to their care plan and process in real time, and help them to better navigate and manage information in complicated, stressful situations. This shows an important need for designing an information system available for patients' information needs, such as a clinical dashboard for patients. The existing dashboards in the clinical environment are designed to support providers' decision-making only by providing all the relevant and timely information they need to inform the daily decisions that improve the quality of patient care (Dowding et al. 2015). At my field site, the default page of the EHR system that providers use is a type of dashboard called "Grease board," displaying the current care status of every ED patient for

a given provider, at a glance. The information displayed includes patient names, bed numbers, names of care providers in charge, chief complaints, orders placed, status of results, admission status, and other notes. This dashboard enables easy access to multiple sources of data, which are all captured locally, in a visual, concise and usable format. A tool similar to this clinical dashboard could be designed to support patients' information needs, like a patient-view tool in the EHR. Using this patient-view dashboard during their ED stay, each patient could access her/his ongoing information, including care process information, care goal information, and even medical knowledge-related information. They could also check any changes and updates in real time, along with their limited interactions with providers. I suggest that including a patient-view feature in the EHR would open up more opportunities for designing patient-centered technologies within clinical settings. This would significantly improve the current imbalances among ED stakeholders in the information environment by addressing patients' information needs as well as enhancing patient-provider communication, even though further research may be needed on data visualization techniques before implementation, since there is some variation in patients' health literacy.

2. ***Support the intermediary work:*** Medical practices can be generally similar in terms of the limited information access for patients and caregivers during ongoing care, but local factors in the ED, such as patient volume, mobile workflows and the availability of providers all interact and affect the ways in which patients access and receive care information. In the emergency care setting, information does not come directly from the original information source, such as the EHR or the head physician; instead, intermediation by care team

members occurs when the patients need or want to know information, or are not capable of understanding it. However, as seen in the study, the intermediary, usually the bedside nurse in this case, is often too preoccupied to deliver information in time or to recognize the patient's information needs effectively. Thus, some of the patients' adaptations were developed to cope with the absence of the bedside nurses who were busy executing multiple orders from different physicians for different patient cases, and to find available informants nearby. Therefore, I suggest creating a new supportive role, such as hospital volunteers or bedside assistants, who can serve as intermediaries by assisting in effective information delivery between the information source and patients, supporting the medical knowledge patients may need, and overseeing patients' needs and behaviors. This new role can also enhance the job of intermediary by providing proper feedback to care team members about patients' ongoing needs, which will be incredibly helpful for the bedside nurses who often need to prioritize performing medical tasks over being an information intermediary.



## **CHAPTER VI.**

# **CONCLUSION**

In this dissertation, I have described two studies conducted in an ED of a large hospital to examine the adaptation practices of different stakeholders. The first study examined how healthcare providers engaged in the adaptation process after a large-scale sociotechnical system deployment; the second study examined how patients engaged in adaptive behaviors in this sociotechnical environment during their ED stays. Through the findings of these two studies, I have shown that these two stakeholders actively participate in their own adaptive processes, with significantly common characteristics.

In this final chapter, I first discuss the common characteristics of the two adaptation processes; namely, how adaptation for both of these stakeholders is considered a design practice, and how both of these adaptations consist of two types of goals – one goal addressing immediate breakdowns and the other addressing healthcare specific needs – both of which are undervalued, yet crucial parts of healthcare organizations. I then draw lessons from these adaptation practices to benefit the design of sociotechnical systems.

## **Adaptation as Design**

Based on the analysis of ED work practices after the EHR deployment, I contend that the adaptation process comprises a significantly large design component. This new perspective can benefit the fields of HCI and Medical Informatics, since prior literatures often argue that adaptation behaviors emerge from problems in system design, and view them as the negative consequences of the deployment (Azad and King 2008; Koppel et al. 2008; Tucker and Edmondson 2002). Most previous works have considered workarounds to be negative results (Kobayashi et al. 2005; Vogelsmeier, Halbesleben, and Scott-Cawiezell 2007; Zhou, Ackerman, and Zheng 2011) or subsume them in the process of an evaluation of the system (Kobayashi et al. 2005), and have focused instead on the workarounds, themselves, rather than studying how and why these workarounds developed. In contrast our findings suggest that adaptation is an end-user design process, and I highlight the importance of understanding the socio-technical systems and design rationales behind these design activities.

My study uncovers similar patterns of adaptation behaviors between the two main stakeholders in the ED – clinicians and patients. They both adapt to a socio-technical environment by actively creating workarounds and strategies when information and technologies are not readily available and/or do not adequately meet their needs. The active involvement of clinicians and patients in developing workarounds clearly illustrates the value of an end-user-driven design process. For instance, providers created a new documentation artifact (e.g., personal notes), redesigned their workflow and physical work environment (e.g., relocating printers), and designed a new policy and intermediary role. Patients devised various

ways of obtaining information (e.g., utilizing physical cues in surroundings), managing information (e.g., creating and keeping notes), and preparing contingencies (e.g., coming up with alternative plans and revising iteratively).

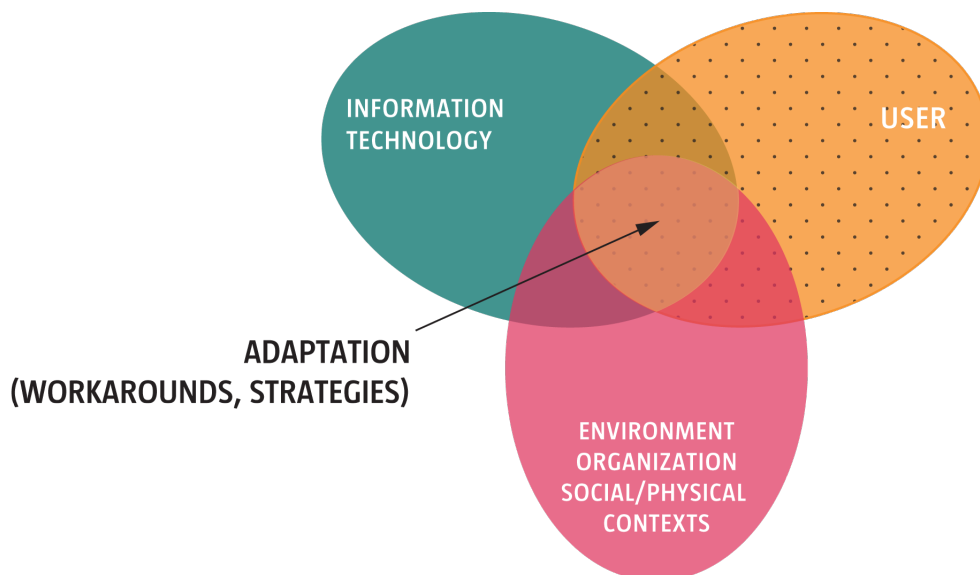
This study shows that adaptations were the result of the users' active design efforts. Clinicians participated in the design process and strove to make the new system workable in the ED. When clinicians' work practices were impacted by the system, they were forced to become invisible designers and had to redesign the system through various adaptation efforts. In a similar manner, patients and caregivers also engaged in different coping strategies in order to manage information breakdowns and strove to get the resources they needed during their ED stays. When patients entered the ED – a chaotic, unfamiliar care environment with limited access to information, they also had to try out different ways to get their information needs met, and to design their own ways to solve and prevent these breakdowns. These findings reveal new opportunities to engage end-users in the design process. In designing complex working systems, conventional approaches, such as the participatory design method, might not be effective, because participatory design tends to only occur at the early stage of the design process, instead of being used for other later stage design activities. Although recent discussions on participatory design have recognized the challenges and benefits of moving toward a sustained long-term process in product development, (Björgvinsson, Ehn, and Hillgren 2010; Carroll 2004), it still remains difficult to capture the complexities and challenges in the actual context through the method. Hence, I think that the end-users' role in the adaptation process is actually a more advanced, active type of participatory design. Furthermore, I argue that the invisible design work performed through the system adaptation stage by end-users can offer

valuable insights to the design community, and that this active design activity should be acknowledged to inform design practices for similar complex working environments.

The adaptation of system use is usually examined as a “deployment study” or a “system evaluation” (Henderson and Kyng 1992; Zhou, Ackerman, and Zheng 2011). In contrast, I consider adaptation an *end-user design process*, where end-users participate in creating new uses, tools and contexts to perfect the working system. Design and evaluation are closely related (Henderson and Kyng 1992), yet typically separated in practice. Although they share a common goal, the evaluation community primarily emphasizes the evaluation of designed artifacts, whereas the design community focuses primarily on the design of artifacts that will be evaluated afterwards. From this conventional standpoint, the ED clinicians’ adaptation stage may be regarded as an evaluation of the system. However, I consider it to be the design of a sociotechnical system. The clinicians did not simply reveal deficiencies in the systems; they also created new usages, new tools and new work practices in the process of adapting to the new system. From this perspective, design does not end at the moment of the system rollout; rather, it is extended to the point when the adaptation process happens and includes user engagement. Therefore, a lack of understanding of this end-user design process during the adaptation period could lead to design efforts being left out – new artifact creations, different artifact uses, and/or technology and user environment reconfigurations might not be recognized and incorporated into the next iteration of design.

In addition, it is crucial to include the other, secondary stakeholders in this design process because they provide valuable insight for designing systems for the sociotechnical environment. As indicated in the study, the impacts of EHR system design are not limited to its

primary users and healthcare providers, but also indirectly affect the patients' work practice. Needing access to contextual information in real time, patients actively engaged in making design efforts, through realizing breakdowns, configuring available resources, modifying their behaviors and expectations, and developing different coping mechanisms, in order to work better within the ED care context. Doing this, patients have adapted to the sociotechnical care environment where unavailable and inaccessible health information forced them to create their own coping strategies. Such adaptive behaviors can inform future designs of health IT that support patients' information needs in the clinical settings. Furthermore, understanding patients' adaptation practices can inform a way to envision and design a socio-technical environment that encompasses the practices surrounding different stakeholders, types of patient care, clinical workflows, existing technological uses, as well as shared information systems.



**Figure 6.1** Adaptation as design

## **Adapting to Sociotechnical Environment, and Adapting to the Healthcare Practice**

My dissertation findings have uncovered that there are common characteristics in the adaptation practices of the two ED stakeholders, healthcare providers and patients, even though they have different needs, motivations, and approaches to adapting to their own sociotechnical environment. First, both participate in realizing breakdowns and problem-solving behaviors in the ED in what can be considered an adaptation process – providers create workarounds to adapt to the newly deployed system and patients develop coping strategies to adapt to the newly encountered care context. Second, both of these adaptation types are active end-user design processes, as discussed in the previous section. Lastly, the commonalities between the two adaptation practices consist of two adaptation goals. I have found that the clinicians' adaptation process comprises two stages – an immediate technological adaptation and a consequent organizational adaptation. The technological adaptation is an effort ED clinicians made to adapt to the new system-in-use. In contrast, the organizational adaptation is a departmental or organizational-level effort to control the quality of information and care after the immediate technological adaptation. Similarly, the patients' adaptation process contains two similar goals – the first is to bridge information breakdowns just like the technological adaptation of the clinicians, and the second is to address the safety and efficiency concerns specific to healthcare practices and the patients' own care needs. The latter is different from the collective organizational adaptation process in which the whole healthcare department works

on organizational adaptation; the patient's adaptation is driven by an individual proactivity, with a broader, higher-level effort to maintain the quality of the care they receive.

I argue that the goals of both adaptations are necessary and must co-exist, since it is imperative in the healthcare field to not only make the system work, but also to ensure healthcare specific needs are met (e.g., efficiency, quality control, safety, etc.). However, my study notes that the latter, organizational and practice-driven adaptations are a critical, yet undervalued component of healthcare practice.

Despite the importance of organizational adaptation, most health IT implementation literature has focused on the users' responses to technology (technological adaptations) in the adaptation process, without considering the consequent effects of these adaptive behaviors from the organizational perspective. Very few health IT studies have mentioned the later stage of adaptation (Goorman and Berg 2000; Novak et al. 2013) For instance, Novak and her colleagues reported individual, as well as organizational-level adaptations. After the BCMA implementation, nurses had to integrate a new set of procedures or artifacts, as well as an orientation to medication safety, into everyday work (Novak et al. 2013). However, as noted by the authors, this research uncovers only minimal organizational adaptations. The authors suggest future research is needed to examine the evolving process of health IT adaptations more systematically. In particular, the study calls for investigating the questions of "how adaptations evolve" and "what classes of adaptations are found following technology implementations." The findings in our work provide empirical insights into these questions, since the contribution of this research lies in the identification of the two types of interrelated adaptations, and discusses how one type of adaptation evolves into the other in a highly reliable work domain.

The findings of my study suggest that the latter organizational-level adaptation was deeply rooted in the high quality assurance requirements set forth by the health organization. It calls for a careful consideration of an organizational-level adaptation process in similar organizational settings. Designing for organizational/management level adaptations requires a careful reviewing, assessing and re-evaluation of the consequences of technological adaptations, and discovering misalignments with the goals of the healthcare organization. Further, future research may benefit from such adaptations by interviewing the department or institution's decision makers and leaders and discovering the ways in which organizational bodies recognize, facilitate, and develop adaptations.

In a similar manner, the goal of addressing healthcare specific needs in the patients' adapting behaviors has not been recognized. As mentioned before, the need to provide information access to patients in hospitals has only been recognized by a few recent studies. However, the coping practices patients currently engage in during ongoing care, and their adapting behaviors for the sociotechnical environment, are new insights from the current study. In today's complex healthcare systems, medical errors cause substantial harm and even death among hundreds of thousands of Americans each year ("Deaths by Medical Mistakes Hit Records | Healthcare IT News" 2015) Although this problem has received national attention, very little work has actively looked at the patients' behaviors in protecting their own safety, such as monitoring, detecting and preventing potential errors in health practices; and less is known about how such patients behaviors can potentially benefit care efficiency and effectiveness among providers' clinical work (e.g., facilitating their care process to speed up). The findings in my study reveal that this broader, healthcare practice-driven goal of patient



adaptation is based in assuring the quality of care they receive in the health organization, which is different from the goal of accessing information to meet their basic information needs. The patients' adapting behaviors that address their own safety and efficiency concerns call for an urgent attention to support patient adapting behaviors in a hospital or emergency setting, as well as to incorporate them into the designs of a health IT in the clinical practice. This specific type of patient adaptation can also provide potential design opportunities for future technologies that can facilitate and promote patient engagement, by allowing them to monitor their own safety, such as medication overdose, mal-functioned machines, and other human errors.

Through the findings of my thesis, I identify implications for healthcare and design practices.

*Collective policy-driven approach.* My study points out that the adaptation to healthcare practice needs to be addressed from a more collective, policy-driven approach. First, for ED clinicians, the organizational adaptation takes place as a consequent response to solve the problems that arise after the immediate response, and is also driven by collective departmental/organizational goals. A number of system implementation studies have examined clinical workarounds and have focused on ways to make health IT systems successful and compatible with healthcare practice. However, healthcare is a unique work setting regulated by many organizational/institutional standards and management norms. These norms and regulations require us to consider concerns beyond the goal of simply making the system work; it is also necessary to make the entire healthcare practice functional and sustainable. Thus, this imposes new requirements and additional instances of adaptation, just as I have seen in the

organizational adaptation in the adaptation process of our study. This new insight also ventures beyond the scope of previous literature on workarounds and problem-solving practices.

Existing literature on the health IT implementation mostly focuses on the first immediate adaptation, such as the clinicians' use of problematic workarounds. Therefore, it is very crucial that the consequent organizational-level adaptations are recognized and highlighted in system implementation. Careful internal analysis might be necessary to identify which adaptations (here, organizational adaptations) should be supported, rather than merely eliminating problematic immediate adaptations. This requires policy-driven solutions by diagnosing and addressing workflow problems that may lead to patient risks, ultimately impacting patient safety, rather than mere technical system design changes, to address healthcare practice needs.

Second, for ED patients and caregivers, adaptation behaviors are largely driven by individual endeavors, as opposed to ED clinicians whose adaptation behaviors are driven by collective group endeavors or organizational control. Patients' adaptation practices emerged and developed independently based on each case. Each patient had to detect, tackle, and solve problems situated in their own emergent care situation. This informs a design need at the policy level for providing collective ways to help patients understand and better adapt to the unexpected ED care environment, such as informing effective strategies to handle problems, instead of leaving patients to discover coping methods alone. For example, patients who have very low health literacy, or non-native language abilities, may have an extremely difficult time noticing breakdowns and approaching them with useful strategies, even if they make an effort. Also, since all individuals do not always equally know or understand the specific needs, characteristics, and requirements of healthcare and ED practices, it would be very helpful to

have guidelines or protocols that inform basic information needs and allow patients and caregivers to share useful strategies, applicable to their ED situations. Guidelines regarding the general ED patient care process (e.g., the order of care phases from triage, basic test, physician consultation, up to discharge/admission), the roles of ED care team members, facility information, the average test time for routine tests, the frequent reasons for long waits, and useful questions for patients to ask their providers, would aid patients' and caregivers' understandings of what to expect from their ED care, where to look for help, and what to look out for during ED stays.

Moreover, in its analysis of immediate and consequent adaptations, my work highlights the importance of policy-making and the institutional/ organizational context, which have not been generally considered in the literature on information infrastructure system implementations. In their review of 25 years of CSCW research in healthcare, Fitzpatrick and Ellingsen note that only a few studies focus on the 'policy' level (Fitzpatrick and Ellingsen 2013). As they point out, most studies describe the current situation of the healthcare setting from the perspective of clinical or organizational work practices, but there has not been much work on analyzing the larger (adaptation) processes related to policy formation and subsequent acquisition after system implementation. My study findings show that in large-scale projects, like the EHR system implementation, a large team of project managers, administrators, policy makers, and health authorities have a crucial role in shaping the technology apprehension and adaptation among users and within the institution, itself. The fact that healthcare is a practice that requires a highly regulated and controlled work environment calls for a particularly strong need for appropriate, updated policies pertaining to system implementation and adaptation. In

deploying socio-technical-political systems, the system needs to be harmonized with evolving work practices and adapted by its users, and its usage also needs to be aligned (or realigned) with broader institutional and regulatory needs; ultimately, implementation must prioritize these broader organizational needs over small-scale work practice concerns through designing policies with system implementation, accordingly.

*Mindful adaptation and new role creation.* In addition to policy level changes, this study suggests that a mindful adaptation process is required and can improve the adaptation process after the introduction of a new socio-technical infrastructure. For the clinicians' adaptation practices, better departmental awareness of the underlying processes of the technological and organizational adaptations will help decision-makers take a more objective or positive approach to shifting practices throughout the infrastructure deployment and ensure that they are focused on moving forward, instead of looking back on the failures which occurred after the implementation. Creating a new role – such as an “observer” who detects discrepancies between the system-intended workflow, actual workflow, and the workflow desired for the purpose of preserving care quality, or an “intermediary” who helps resolve the discrepancies between the hypothetical and the actual, achievable workflows – may expedite the adaptation process by supplementing and improving individual or departmental responses to breakdowns.

With an observer or intermediary role creation, the adaptation practices of patients and caregivers can also be improved. Since patients' adapting behaviors are to address the needs of both accessing health information and maintaining the safety and quality of care, this new role can guide and expedite their adaptation process. For instance, from the beginning of an ED care

process, such as triage, patients can be classified, not only by the severity and acuity of care, which is the existing standardized ED patient classification, but also by the levels of expected patient information needs (e.g., non-native elderly patients who have lower health literacy). An observer or facilitator then can assist the classified groups of patients who are in more need of information help and access, while overseeing the current ED patient situations. This intermediary help can support patients to better and more efficiently adapt to the ED environment without having extra stress and going through the failures of accessing, receiving, and understanding their care information, while also promoting patient engagement.

In summary, through my dissertation study, I find that adaptation is a crucial and essential way to understand what practices may be best in this sociotechnical environment. Thus, understanding and studying adaptations would help develop better work practices, such as creating better workarounds and strategies. It would help to improve system design or make the system become a better fit for real users/important stakeholders and its environment. It would also help develop better contexts, such as creating more appropriate policies, new roles, work requirements, and reconfigurations of physical surroundings. My study calls for system designers and HCI researchers to carefully consider the value to be derived from the adaptation practices of the different stakeholders (healthcare providers and consumers), as well as their two adaptation goals (addressing immediate breakdowns and meeting healthcare specific needs) – for the successful deployment of socio-technical-political systems in a healthcare organization. Lastly, I also call for healthcare organizations to be more critically reflective of their own engagement during the adaptation period through mindful adaptation efforts.

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