

# Technology Readiness through Collaborative Reflection: A Qualitative Case Study of an Under-Resourced Nurse-Managed Clinic

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## Abstract

*This paper reports how a nurse-managed primary care clinic (NMPCC) prepared for the implementation of an Electronic Health Record (EHR) system with limited resources. EHR adoption is a complex task that requires not only implementing a system but also an integration of the system into the existing sociotechnical environments. In this study, we identified three stages of the process improvement meetings conducted at the clinic: (1) understanding routines, roles, and practices, (2) identifying problems and deficiencies, and (3) iterating interventions by optimizing resources through reconfiguring artifacts and work practices. Importantly, we found the staff jointly reflecting on one another's experiences and practices by making sense of the collaborative work. We regarded this sense-making process as collaborative reflection, and argued that it enhanced technology readiness of the NMPCC through creating a more technology-compatible and collaborative sociotechnical environment for the impending EHR implementation.*

## 1. Introduction

The implementation of health information technology (HIT) in clinical settings, e.g. Electronic Health Record (EHR) systems, is challenging and often associated with a variety of adoption barriers, such as the design of systems that do not support frontline clinical processes [1][2] and resistance from end-users [3][4]. HIT adoption requires not only system deployment, but also a seamless integration of the system into existing patient care practices that include workflow, team coordination, as well as established norms, culture, and policies in local practices [5]. Even well-planned EHR deployment can lead to unintended consequences such as decreased efficiency and increased threat to patient safety [6], frequent and unplanned interruptions in the workflow, development of workarounds that often worked against the system design [7][2], perpetual resistance, and sometimes failure in adoption [3]. To avoid these issues, many health organizations spend tremendous efforts and resources to prepare for their imminent EHR adoption.

Most prior studies investigated the EHR adoption process after its deployment; they mainly focused on large health organizations, e.g. [1][7][8][9]. These

studies have identified various unintended consequences, often resulting from the gap between the current sociotechnical context and the demand of new technologies. Sociotechnical issues are considered crucial for successful HIT adoption, and they consist of a variety of factors such as organizational culture, team morale, work processes, and IT policies [10][11]. To narrow the gap, many health organizations are actively engaging in various pre-implementation strategic planning such as user training and policy adaptation as ways to prepare for their upcoming implementation. However these efforts are often expensive and require substantial resources.

Very few studies have examined the EHR adoption in small and under-resourced environments prior to the introduction of the system. Dennehy et al. investigated HIT deployment in several small nurse-managed health centers, but they only focused on the effectiveness of their partnership model in supporting organization-level readiness for EHR systems [3]. In reality, under-resourced healthcare organizations such as nurse-managed primary care clinics (NMPCCs) often face severe financial challenges that can impact their survival in the competitive healthcare climate [12]. Yet, NMPCCs play a crucial and indispensable role in the U.S. healthcare system [12], where nurse practitioners provide holistic patient care services to underserved and vulnerable populations. Studying how NMPCCs use limited resources to prepare for the adoption of a system with a high price tag such as an EHR system would make an interesting case for understanding how under-resourced organizations struggle to provide services with cutting-edge technologies. It is also interesting to explore how they optimized and strategized the use of limited resources available to them.

Our study is part of a larger research project to investigate the transition from a paper record system to an EHR system in a NMPCC. This paper reports our findings from the initial stage of exploring different EHR systems available to the time when a particular system was obtained. The timing that the study was conducted provided us a valuable opportunity to capture early preparation activities that would not be possible in other retrospective studies.

Like most other NMPCCs, our study site is financially constrained, understaffed, and limited in resources. In fact, this clinic had previously been at the edge of closing down due to financial difficulties, as reported by its leadership. With the goal to attain financial sustainability in the long run, the leadership had to make the right decision on the prospective EHR system and ensure that the system will integrate smoothly into the clinical, social, and technological environment of the clinic.

With these important and challenging goals in mind, the clinic's leadership decided to take a proactive approach for the upcoming challenge. Striving to enhance the EHR readiness of the clinic and its staff, the nurse manager initiated and organized weekly process improvement meetings with the medical and administrative staff. The goal was to identify problems and deficiencies in existing work practices and develop improvement plans. These meetings were initially intended for unstructured brainstorming only but were gradually evolved into three relatively distinct stages: (1) understanding routines, roles, and practices, (2) identifying problems and deficiencies, and (3) experimenting with interventions through reconfiguration of artifacts and work processes.

Incidental to our observations during the process improvement meetings and beyond, we identified an important phenomenon where individual staff members cognitively reflected on their own past experiences and practices [13], which they then collaboratively reflected on and derived action plans for improvements – a process we regarded as collaborative reflection. Such interaction played a crucial role in enhancing mutual awareness and understanding of work tasks among the clinic's staff and created a better socio-cultural environment for the new system implementation.

Our findings indicated that collaborative reflection can be adopted as a cost-effective means for under-resourced healthcare organizations such as NMPCCs to enhance their readiness for new technology. We also unpacked the tension between the urge for immediate intervention to address ongoing issues and the consideration to postpone fixes by an impending EHR system while developing transient interventions. The former was primarily achieved by optimizing existing limited resources at the clinic. Finally, our findings showed that collaborative reflection could help build a stronger team that facilitated collaborative work.

The findings of this paper set the scene for further research in studying more broadly how organizational improvements for technology adoption and integrations may be enhanced through low-cost mechanisms or facilitations such as collaborative reflection. Our findings can benefit under-resourced health settings to

become better prepared for technology deployment and resource optimization through collaborative reflection.

## 2. Related Work

HITs have the potential to improve the quality of care and the efficiency of healthcare delivery, e.g., through better documentation and improved tracking capability for patient care activities [9][14]. Healthcare settings are well known to be complex, dynamic, information-rich, and distributed. Thus technology deployment in these settings is particularly challenging, contributing to the low adoption rate of EHR despite its perceived benefits. For example, only 17% of physicians in private practices have adopted EHR systems [9], and only 1.5% of 63% of US hospitals surveyed in 2009 have implemented a comprehensive EHR system [15].

### 2.1. Challenges of EHR deployment

The low EHR adoption is due to a number of reasons such as financial cost [15], system design [1][2], concerns over reduced productivity due to new system integration [16], and organizational factors such as governance, culture, and qualities of leadership [9]. Even resource-abundant and technologically competent organizations can fail with its adoption. For example, clinicians did not fully integrate the system into their day-to-day clinical routines because of their overall negative attitudes toward the use of EHR in clinical care and their perception of the implementation being unsatisfactory [17]. In particular, premature EHR deployment has resulted in frequent and unplanned interruptions in the organization's workflow. Clinicians also developed workarounds that often worked against the system's design intentions in order to adapt to the system [2][7]. Premature EHR deployment, furthermore, could lead to perpetual resistance and even failure in adoption [3].

Even successfully deployed systems could fail to generate anticipated results because of, e.g., poorly planned implementation that lacked a systematic understanding of users, tasks, and environments [14]. System deployment was also sometimes associated with unintended adverse consequences [18] such as reduced efficiency, increased threat to patient safety, and compromised patient care [6]. These consequences may not only impede the implementation and diffusion of HIT in clinical settings [8] such as when clinicians ignored as many as 70% of technology-generated clinical alerts [19], but also potentially jeopardize the quality of healthcare. Thus a good understanding of prospective end-users and existing work practices during pre-deployment could facilitate technology adoption [20].

Frequent failure to adopt HIT has motivated researchers to explore how healthcare organizations could better prepare for an upcoming HIT deployment. Evaluating the technology and organizational readiness

has been a common approach [21]. For example, organizational readiness encompassed an organization's readiness to accept change, its collective self-efficacy, and the effectiveness of its leaders, which were considered critical to HIT deployment [22]. Snyder-Halpern used a Dephi study to develop a taxonomy of organizational readiness for HIT deployment that summarized key factors needed for successful adoption of technologies: resources, staffing skills, knowledge, process, values and goals, operations, and administrative support [23]. Many of these factors however were absent in many health organizations. It was thus suggested that creating an environment with these key factors was critical prior to technology adoption [24].

## 2.2. Challenges of under-resourced settings

Resources needed for successful HIT adoption included financial support, IT personnel and their expertise, and IT budget control [23]. Yet many of these resources are scarce in most under-resourced organizations including NMPCCs. NMPCCs face significant financial challenges that made them particularly vulnerable within the competitive healthcare domain [12] in addition to the challenges commonly encountered by healthcare settings. Thus they are generally inadequately resourced and under-staffed.

Moreover, most vendors prescribe a "one-size fits all" approach and are typically reluctant to provide needed support or customize the deployment plan to fit the EHR system within the practices and sociotechnical environment of health organizations, particularly the small and resource-constrained ones like our study site [3]. The leadership in NMPCCs therefore has to make the right decision on the EHR procurement and deployment. This is because any changes or removal of the system after deployment would result in substantial financial and organizational consequences in addition to increased medical errors [6], and unfortunately these resource-limited clinics would not be financially viable for any remedial contingencies.

A good understanding of current practices in the sociotechnical environment of a health organization through a user-centered approach similar to participatory design and contextual inquiry before the actual EHR deployment could help prepare for technology implementation [4]. For resourced-limited NMPCCs, a low-cost mechanism that allows people to reflect on their past experiences, identify issues and deficiencies for improvement, and share and learn from one another in a social context would likely be useful to enhance their readiness for EHR implementation and integration.

## 3. Methodology

Our research set out to broadly investigate the transition from a paper record system to an EHR system in a NMPCC. In the study, we observed current

operations at the front desk and the nurse station, particularly on how artifacts were used and how work was carried out. We also observed patient-provider interaction inside the exam rooms and how medical assistants and nurse practitioners used patient charts during pre-assessment and consultations respectively. Informal interviews and document reviews were also conducted to understand their charting practices and to verify our interpretation of their behaviors.

Most relevant to what is reported in this paper, we observed the weekly process improvement meetings that the nurse manager organized for improving the readiness of the clinic for the impending EHR. We report the dynamics and interactions in these meetings and how these interactions led to improved work relationships among the staff during the practice of their work.

**Setting.** The research site is a NMPCC affiliated with a local university in the Midwestern United States. Patients of the clinic are students of the university who have subscribed to the Student Health Plan and residents who had no, or low-income as specified by local health plan agencies. This clinic operates on capitation, i.e. it receives a fixed fee per enrollee at the clinic rather than a fee for services provided. There are currently about 1,200 patients enrolled with the clinic. The clinic is anticipating the deployment of an EHR system.

Figure 1 shows the layout of the clinic. The front desk is equipped with two desktop computers for scheduling appointments, and retrieving patient insurance and billing information. The nurse station has two computer workstations for medical assistants and a common workbench for nurse practitioners. All of the computers are installed with a text messaging system for communication. There are four exam rooms, which together with the nurse station, are equipped with an open-link intercom system. Intercom communications from and to the front desk are conducted through a designated telephone in the front desk.

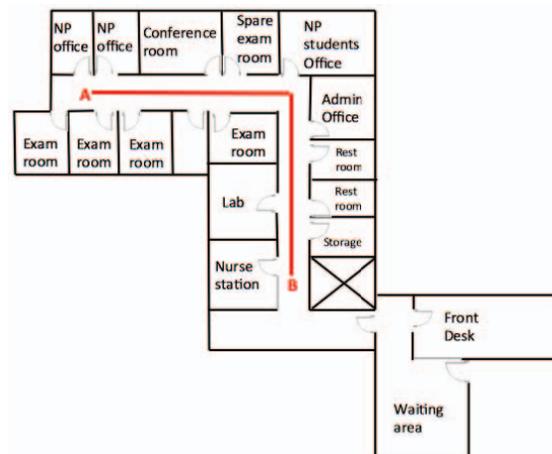


Figure 1: Floor plan of the study site, showing walking path between exam rooms (A) and nurse station (B).

**Participants.** Participants of the study were an administrator, two nurse practitioners (NPs), two medical assistants (MAs), and two front desk assistants (FDs). One of the NPs was also the nurse manager who oversees the daily operation of the clinic. The administrator and the nurse manager both undertook the leadership role; the latter organized and moderated the process improvement meetings. All of the participants were full-time employees.

**Data Collection and Analysis.** The qualitative findings reported in this paper are based on observations over two months (approximately 80 hours of observations and 10 hours recordings of informal interviews).

This paper focuses on observations during the process improvement meetings taken place in the conference room. Observations were also conducted at the front desk, nurse station, and in exam rooms. All the observations were recorded on paper. Informal interviews with participants were conducted intermittently throughout the study, mainly for clarification and elaboration of their actions. Interviews were recorded with prior consent from participants. Participant shadowing was conducted with a NP and MA for one day each. We also reviewed documents such as patient charts to better understand how the documents were used and what information was recorded. The handwritten notes and the recorded interviews were then transcribed and elaborated for data analysis.

Data analysis was carried out continuously during the study. The transcribed data were examined to identify information and communication points and workflow using flow diagrams. Affinity diagrams were used to identify important themes of the findings. Observations during the process improvement meetings were first analyzed, then together with other observational data to understand the impact of the meetings on the daily operations and work practices at the clinic.

## 4. Findings

In the following, we present the team dynamics and activities during the process improvement meetings. We report how the interactions helped the staff members (1) uncover routines, tasks, work practices, and their interdependencies ; (2) collaboratively critique and identify inefficiencies, redundancies, conflicts and tensions; and (3) jointly make action plans for improving current operations. We then describe two examples of how problems and solutions identified at the meetings were pursued in practice.

### 4.1. Process improvement meetings

To prepare the clinic to be ready both culturally and operationally for the new EHR system implementation, the NMPCC organized weekly process improvement meetings with all of the staff members in the conference

room. The nurse manager served as the moderator at the meetings. Low-tech artifacts such as whiteboards, flipcharts, and sticky notes were used to aid the discussions. The meetings were generally unstructured, but we identified three key stages of activities in the meetings over the two months of observations:

- Staff individually recalled and constructed their tasks in a temporal order, then collaboratively created overall workflows of the operation at the clinic.
- Staff examined their tasks and identified deficiencies that would hinder the adoption and use of new technology.
- Staff brainstormed and proposed interventions and solutions for addressing the problems identified in the previous stage. Since the EHR system has not been implemented, the interventions and solutions were typically achieved through reconfiguration of existing artifacts and work practices. In effect, these solutions would make the NMPCC a better working environment that is more compatible with new IT systems.

**Understanding routines, roles, and work practices.** □ In preparing for the EHR deployment, individual staff members recalled their own tasks and routines which they wrote down on separate sticky notes, followed by co-constructing these tasks on a flipchart as workflows in the context of the entire clinic operation (Figure 2, left). □

**Recalling individual tasks.** Staff of the same role first recalled and listed the tasks that they carried out using separate sticky notes. They then arranged the tasks chronologically on a flipchart to show the flow of their work (Figure 2, left). Most of the tasks carried out by staff of the same role were the same but some were different as they split up those tasks between different staff. For example, a MA was responsible for the entire quality control of lab supplies whereas the other MA was in charge of all the patient follow-ups. The resulting workflows of each role covers all of the tasks performed by staff of the same role. This way the staff could see all the tasks a specific role was responsible for and the temporal relationship in carrying out these tasks. □

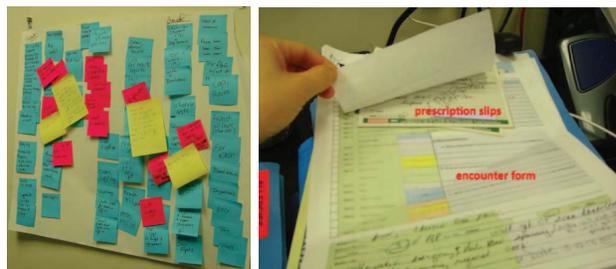


Figure 2: (left) Blue sticky notes arranged chronologically as workflows, with problems in red and proposed solutions in yellow on a flipchart; (right) An encounter form inscribed with brief notes made during consultation, and filled prescription slips.

*Building workflows with respect to entire operation.* After individuals identified their tasks and routines, the team then co-arranged the sticky notes to create workflows to the interdependencies of different roles and the tasks for the whole clinic. Additional tasks and routines were added to the workflows when staff members recognized any missing tasks. For example, after reviewing the tasks for lab work, a front desk assistant pointed out that writing down patient information on the lab sample labels was missing, so it was added back to the workflow. Thus the resulting workflows consisted of a comprehensive set of tasks and routines across different roles in a temporal order.

The first stage of process improvement meetings allowed staff members to gain a better understanding of work routines and workflows across multiple roles in the clinic. This understanding is beyond the individuals' own daily practice and provided them an opportunity to re-orient their understanding of the clinic operation.

*Identifying problems and deficiencies.* To be better prepared for the new digital practices, the staff agreed that deficiencies in the existing operation should be addressed before the upcoming rollout, particularly the problems that may hinder the future EHR adoption and use. To do that, the staff discussed and evaluated the comprehensive set of tasks and routines created by them earlier to identify issues such as inefficiencies, inconsistencies, conflicts, tensions, and redundancies.

Some of the problems the staff identified were historical but had not been properly addressed. For example, patient appointments had frequently disappeared unexpectedly in the Excel spreadsheets that were used to track appointments in current practices, but nothing had been done to rectify the problem. The staff also identified problems they previously didn't recognize. For example, through the discussions, medical staff found that the current patient chart filing system was problematic, resulting in an incident where patient documents that belonged to nine different patients filed in a single patient chart. The staff discussed these problems, and then ranked them according to its severity. Problems with serious consequences received immediate attention and were addressed in subsequent meetings.

The staff actively engaged in brainstorming possible solutions when discussing identified problems and

issues. For example, staff who had experiences in dealing with the same or similar issues in their previous workplaces often volunteered to share their experiences. This kind of experience sharing seldom happened before the launch of process improvement meetings because the staff members were typically occupied with their work. Thus these meetings provided a venue for them to share experiences for addressing issues under discussion, and to offer them a chance to examine the operation of the clinic beyond their own individual work. The staff also raised problems that they anticipated with the use of an EHR system. For example, a staff member expressed her concern about the difficulty of finding information in an EHR system. A MA who had used an EHR system in her previous job described her experience of how that EHR system displayed all of the functions on the same screen and how easy it was to find information in the EHR. This kind of positive experience sharing helped reinforce the staff's attitude towards EHR deployment, which can help facilitate technology adoption [20]. In addition, the process of identifying problems and issues in their work practices helped raise their awareness of existing problematic areas that could then be fixed or improved upon pre-EHR, rather than propagating, and even accumulating, after the EHR deployment.

In short, the second stage of process improvement meetings allowed the staff to critically examine the tasks they performed, and identify deficiencies. They also related their current work with the anticipated EHR system to identify potential shortcomings and respective strategies to adapt to the new technology.

*Reconfiguring artifacts and work practices.* Organizational deficiencies would have negative impact on EHR adoption [20], and lead to breakdowns in routines and work practices. Thus the staff including the leadership were actively seeking for solutions to address issues on both operational and organizational levels.

*Operation-level reconfiguration.* From both the leadership and the operational point of view, operational problems that impacted work performances and efficiency should be addressed as swiftly as possible. However, this was not always the case in our study site, given the fact that an EHR system would soon be deployed. The tension between whether immediate intervention should be applied and whether the problem should wait for the EHR system had to be carefully considered when defining specific action plans. Factors that could impact that decision included the urgency and impact of the problem, whether the problem could be fixed or could only be eased with transitional mechanisms, whether the problem could be addressed using EHR functionality, as well as what resources such as manpower and expertise were required. Therefore, whether and how each problem should be addressed varied dramatically. For example, the filing system of

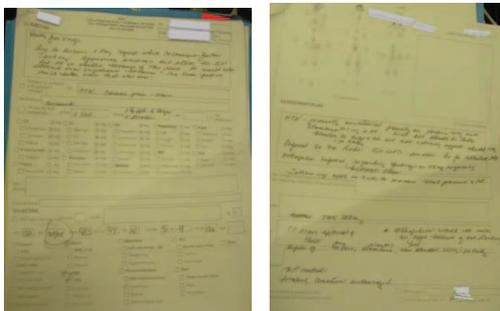


Figure 3: Current progress notes requiring ample textual input

patient charts in the clinic has been considered to be confusing and problematic as the charts were not uniquely identified, i.e. multiple charts could have the same filing identifier. This problem was expected to require substantial resources to fix, and the new unique identifiers may not be compatible with the EHR system while it can be readily resolved with an EHR system. It was also clear that the clinic did not have the financial resources for the transitional remedy. Therefore the staff decided not to take any actions on this problem during pre-EHR. On the other hand, the appointment scheduling problem had been causing a lot of trouble to the front desk assistants because of the frequent and unexpected disappearance of appointments. Even though the staff was sure that this problem would be fixed by the new EHR system like the filing problem, the staff voted for an immediate intervention to improve the existing system because they believed that if this problem persisted, patients' satisfaction would be greatly impacted, causing extended negative effects on the clinic's operation and reputation.

*Organization-level reconfiguration.* Apart from reconfiguring operational processes for the impending EHR deployment, leadership also stepped into an active role in making sure that the organizational infrastructure, particularly the IT infrastructure, is compatible with the EHR system to be implemented. While the leadership constantly updated the staff about the discussions on compliance issues with IT specialists, the staff were encouraged to provide relevant inputs and to adopt new IT measures. For example, to address the ever-neglected network security issues, the administrator instructed the use of a new secure file sharing system, along with the practice of encrypting emails for electronic transmission with third party facilities as a way to prepare the staff for future communications using an EHR system.

Hence, the third stage of process improvement meetings afforded staff members an opportunity to collaboratively brainstorm and propose solutions for addressing the identified problems. Not only were they concerned with improving operational performances, they were also actively involved with organizational enhancements for the impending EHR system.

#### **4.2. Cases on reconfiguring for technology readiness**

To illustrate the process of performance improvement, we present two examples of how problems and solutions identified at the meetings were pursued in practice with collaborative team effort. These cases not only showed the efforts in optimizing the current practices, but also prepared the clinic staff to better understand, anticipate, and get ready for the upcoming EHR system.

*Reconfiguring point of care practice for EHR integration.* In practice, the NPs recorded only brief

notes, typically a few keywords on the progress notes during a consultation. Full documentation was completed later, at breaks or at the end of the day. With the keen expectation of using an EHR system for timely access to and entry of information at point of care, the NPs decided to adapt some of their current behaviors and practices in order to be better prepared for the EHR deployment. One of the proposed changes was to complete charting at point of care. To do that, the staff found that the biggest hurdle for charting at point of care was the design of the paper progress notes (Figure 3), which required them to write down extensive textual documentation instead of checkmarking from a selection of choices. Charting on the progress notes at the point of care would thus be time-consuming and would interrupt patient care. Therefore the staff considered redesigning the progress notes a priority so that charting can be performed more efficiently at point of care. Thus, the redesigned progress notes and the reconfigured charting practice at point of care prior to EHR adoption can be seen as a critical step in enhancing technology readiness at the NMPCC where behaviors and work practices are redesigned to meet the demand of the new EHR system.

#### ***Reconfiguring work practice to improve efficiency.***

With the issues identified in current work practices, the staff started to more actively contemplate what changes they could (easily) make in their daily work to enable a better and more efficient workplace, as well as to be better prepared for an EHR system. As the NPs' work efficiency is crucial to the performance of the clinic, the staff paid particular attention to improving the NPs' workflow. The current practice that had NPs walking with the patient after consultation to the nurse station to photocopy the encounter form for the patient to check out was considered highly inefficient. It was inefficient because of the spatial distance that the NPs had to travel after each patient visit between the exam rooms, the nurse station, and the NP offices, (see the walking path between exam rooms and nurse station in Figure 1) along with the mundane photocopying work itself, which sometimes required the NPs to look for another photocopier when the one inside the nurse station was busy. Even though the use of encounter forms would be replaced by the EHR system, the staff decided to address this issue immediately since it would not require extra financial resource.

The improvement processes were iterative. The staff continually evaluated outcomes of the interventions, and collaboratively revised the interventions if the outcomes were not satisfactory. To improve the NPs' work efficiency, patients were first asked to take the encounter form to the nurse station for a MA to make a photocopy and simultaneously, the NP used the intercom inside an exam room to notify the MAs in the nurse station. However, the NPs often had to revert to the old practice

after wasting time on the intercom because MAs were usually not in the nurse station, which was not uncommon as medical work is highly mobile [25]. Moreover, the shift of responsibility to the MAs increased their already-heavy workload and interrupted their workflow, so this solution was dropped after a brief pilot.

This example shows that even though changing practices of a particular role could lead to positive outcomes in that role's performance, the change may also affect other roles in unexpected, and/or undesirable ways.

## 5. Discussion

In this section, we first discuss a phenomenon that we identified in our study, which we called collaborative reflection. We then discuss how optimizing existing resources through reconfiguration of artifacts and work practices could help enhance an organization's readiness for EHR adoption, and how the staff became a stronger team through collaborative reflection. Finally, we propose technology design for supporting collaborative reflection.

### *Collaborative reflection for technology readiness*

Healthcare is a team-driven effort that is often distributed across space and time. Particularly in large hospitals, healthcare teams are often loosely formed around emergent patient care [26]. In contrast, the team composition and dynamics in our study site stayed fairly stable in their day-to-day practices. Despite its stability, breakdowns in collaborative work could adversely impact team performance and healthcare quality.

Adopting an EHR system is challenging whether it takes place in a large hospital or a small clinic like our study site. We consider the process of "engag(ing) in finding common meanings in making sense of the collective work they do" [27] as a cost-effective means to prepare for EHR deployment. We coined this process as collaborative reflection and consider it crucial in enhancing technology readiness in our field site.

Reflection is a cognitive activity in which an individual recalls and evaluates past experiences, and draws conclusions for future actions [13]. In our study, individual staff members cognitively reflected on their own past experiences and practices. This component of individual reflection is valuable as people typically do not reflect when they act in routine ways [27]. According to the unfreezing stage of Lewin's change theory [28], the understanding of one's work and realizing what needs to be changed is crucial to achieving successful change such as adopting new technology. In our study, individuals then engaged in collaborative reflection to make sense of their collective work [29]. Collaborative reflection allows individuals to jointly reflect in a social context through dialogical communication to share and

process past experiences [30], challenge groupthink, ask for inputs and feedback, and experiment with alternatives [31]. The primary goal of collaborative reflection is problem solving [27]. Our study indicated that the staff learned from one another and acquired new knowledge through collaborative reflection, which apparently can generate more benefits than individual reflections alone.

Collaborative reflection has been widely practiced in settings like hospitals but in different contexts. For example, structured meetings were often held for medical teams to collectively make decisions on patients' diagnosis and treatments [32], and to develop ideas and interventions for addressing problems in patient care [33]. These prior findings, however, were for capturing good work practices for improving the quality of patient care [33]. Yet, the collaborative reflection that we identified in our study was primarily intended for enhancing technology readiness and resource optimization of an under-resourced healthcare setting in three progressive stages of task recollection, problem identification, and intervention development. As the examples we described in the findings section indicate, through discussion and reflection of the day-to-day practices at the clinic, the staff members were able to better understand the collaborative aspects of the work, identify problems such as inefficiencies and breakdowns, and more importantly, adapt their work practices to address these problems actively. These efforts have thus transformed the clinic into a more technology-ready environment that new technology can more easily integrate into [4]. The remedies that the staff developed in response to the identified problems prior to the deployment also allowed them to embark on some EHR-compatible work practices such as their efforts to complete charting at the bedside, avoiding major breakdowns when the new system is introduced.

### *From collaborative reflection to team building*

In the course of understanding each other's work during collaborative reflection, the staff members were actively seeking answers, explanations, and clarifications from their colleagues. Their constructive conversational exchanges helped them understand their own work better and also acquire a different perspective on how others perceived their work. Unexpectedly, the mutual respect and rapport developed during these interactions drove the team to become more considerate and coherent. During our interviews with the nurse manager and other staff, they commented that they have come to know each other better both personally and professionally and they have become a stronger and tighter team. The positive team morale as a result of improved mutual understanding of the tasks and routines is also expected to help decrease the staff's resistance and anxiety towards new technology.

The improved team dynamics were also apparent from their renewed engagement in organizational issues. For example, as the study clinic serves a vulnerable population that is often associated with a variety of social problems such as drug and alcohol abuse, the leadership of the clinic works closely with community partners to deal with these social problems. A community project was being conducted in the clinic for screening patients for drug and alcohol overuse. In a process improvement meeting, the staff members were eager to offer their opinions on issues such as recruitment and coordination strategies so that the project could be carried out successfully without interfering with the clinic's operation. Similarly when discussing another organizational issue that concerned health policies on how the clinic should plan for a projected shortage of TB (Tuberculosis) test kits, the staff participated actively in the discussion. The staff expressed their feelings of importance as part of the organization, since leadership valued their opinions and inputs, contributing to a stronger and more cohesive team in the clinic.

Moreover, the communication and interaction between the staff members while collaboratively reflecting on tasks and issues during the process improvement meetings has positively led to more active and spontaneous collaborative reflection "in-action" when problems emerged in the workplace. During our study, a front desk assistant was unsure about how to handle a face-to-face request from a patient's friend (who was known to the team and the patient was not present) to release the patient's insurance information so that the patient could receive appropriate lab services. The front desk assistant went to ask for help in the nursing station where a MA and a NP were busy with their work. They immediately stopped their task-at-hand to discuss possible solutions with the front desk assistant. The MA later remembered that she had come across a similar situation before and suggested to fax the patient insurance information to the laboratory directly so that the patient could receive the services, and his privacy would not be breached. The staff members were happy with the solution that they had arrived at collaboratively and agreed that this experience would be useful for other similar situations.

Although it is premature to conclude that collaborative reflection during pre-EHR will lead to smooth integration of an EHR system, it is very clear from our observations and interviews that the clinic's staff have benefitted in many ways, and the improved organizational culture is found to be crucial to the adoption of an EHR [34]. The staff have acquired a better understanding of their own and each other's routines and work practices, and have initiated a series of improvements for addressing identified problems. They

have also become more committed to achieving a successful EHR integration into their practices of patient care. In particular, together they have helped build a stronger and more supportive team. Given these benefits demonstrated in our study site – a resource-scarce and understaffed nurse-managed primary care clinic, we recommend other similar health organizations to practice low-cost collaborative reflection for improving their current operations and readiness for new technology. Next, we propose technology design for supporting the process.

## 6. Collaborative Reflection in Practice

Through a series of meetings to understand routines, identify deficiencies, and reconfigure work practices, the staff, including clinicians and other staff, are able to better understand each other's work, form better teams, optimize the use of available resources, and adapt their work practices in preparation for a digital practice. In our field site, the process improvement meetings have turned the clinic into a more technology-compatible, sociotechnical environment for the upcoming EHR implementation. However, process improvement meetings do not always guarantee fruitful reflections and discussions. We believe that the benefits of collaborative reflection lie in the successful execution of these three interrelated activities: (1) understanding routines, roles, and work practices; (2) identifying problems and deficiencies; and (3) reconfiguring artifacts and work practices. Therefore, we recommend organizations to carry out these activities properly when planning the practice of collaborative reflection. We also recommend the use of technologies to facilitate these activities. In the following, we propose several guidelines for supporting collaborative reflections as a means for enhancing pre-adoption technology readiness within organizations. Of special note, our proposed suggestions have taken into consideration that the technology is to be deployed in resource-constrained settings, and we do not assume purchasing expensive technologies an option.

### *Support for Understanding Routines and Tasks.*

Recalling one's tasks is critical to the execution of collaborative reflection. Thus when collaborative reflection is to be practiced in reality, the first step is to ensure staff members actively recall their own tasks, followed by mapping their tasks to the overall organizational processes. To reinforce active engagement in reflection, we suggest organizations to integrate this activity into the discussion agenda and create activities to actively engage staff members. For example, game-style activities can be designed to encourage the staff to call out the tasks performed by another or other colleague(s); role-playing allows staff members to act out a colleague's work to enable mutual awareness and understanding of tasks. Similarly,

mapping out the entire workflow and work processes can be done by collaboratively sketching on a large display like a flipchart or arranging flash cards of identified tasks. We also recommend a persistent display of the resulting workflows in a location where staff members can continue to review and comment on after the meetings.

To support these activities, technology should be designed to provide lightweight mechanisms for staff members to easily record tasks and reflections, and to upload to a centralized location. It should allow integration of individual workflows into a collective workflow, and allow joint re-ordering and branching of tasks. Easy switching between individual and collective workflows should also be supported. An ideal technology for manipulating the workflows would be a large multi-touch digital display if available. Alternatively, single display groupware [35] that allows multiple mice interactions would be useful.

**Support for identifying problems and issues.** Depending on the complexity of the workflows built in the previous stage, problem identification can be a daunting task. The issues to be identified in this stage should include not only the breakdowns and inefficiencies in current work, but also issues that might be incompatible with the new technology. Doing so would avoid some major adoption barriers such as the required point of care documentation in EHR and the current post-visit charting practices.

We suggest employing a widely used technique called divide-and-conquer in Computer Science to examine and identify problems in subsets of the workflows. Different visualizations supported by technology can also facilitate the identification of problems [36]. For example, a complete display of workflows provides an overview of operation to help locate problematic areas, whereas a focused view of a task or a set of tasks can help identify more subtle issues. Thus a focus-and-context visualization would be useful by providing flexible visualization at different granularities. In addition, particularly in large complex workflows, visual cues such as colored flags should be available for tagging problematic areas of varying levels of severity, analogous to the color-coded sticky notes used in our study site. Furthermore, a narrative feature for documenting specifics of problematic areas has been shown to be useful in our study that elaboration was made on a whiteboard during collaborative reflection. The availability for narratives is particularly useful when problems are to be addressed at different stages over time, so that the subtleties can be saved and continually documented until the problem is resolved.

**Support for feedback on interventions.** Although collaborative reflection offers an opportunity for groupthink to derive solutions for identified problems,

the solutions may not produce results as expected. In some situations, the problems may only be shifted without being solved, as evidenced in our study. Therefore, we deem it necessary to provide a venue for the staff to continually evaluate the outcome of interventions, and to express their concerns and make recommendations for improvement.

To do this, technology can be designed to allow staff members to easily make suggestions and to record their experiences with interventions. Lightweight documentation mechanisms that are ideally equipped with easy inputs of feedback such as including a set of pre-set responses for selection, can be designed to facilitate the evaluation of intervention outcomes and impacts, and if needed, the generation of alternative interventions for addressing the identified problems.

These proposed solutions would engage staff in an organization to better understand both their own individual practices and the overall operation of the organization, to reinforce team building efforts, as well as to adapt to more technology compatible workflow and behaviors. Together, these efforts will lead to a reconfigured and better sociotechnical environment that is more compatible for the new technology. We expect our proposed solutions will be useful not only in healthcare settings, but also other domains where the practice of collaborative reflection could benefit their operations or their readiness for new technology.

## 7. Conclusion

This paper reported the dynamics of the process improvement meetings conducted in an under-resourced nurse-managed primary care clinic as a means to prepare the clinic and the staff for an impending EHR system. We identified three stages of activities in the meetings: (1) recalling tasks and practices, (2) identifying and evaluating problems and issues, (3) proposing and iterating solutions for identified deficiencies. We further showed that the process that the staff collaboratively identified common meanings in their work practices as collaborative reflection, which is a cost-effective approach to enhance organizational readiness for technology adoption prior to the system rollout. Given the limited resources at the clinic and through collaborative reflection, proposed solutions were shaped by the consideration that an EHR system would be deployed soon to fix the problems and the need to run an ongoing operation with quality patient care. Thus, the interventions were accomplished largely by optimizing existing resources through (re)configuring new or existing artifacts and work practices. Our study also identified a stronger team in the clinic through collaborative reflection and indicated an increased readiness for technology adoption and integration. Finally we concluded with practical design implications to inform collaborative reflection in organizations.

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