

# From Troubleshooting to EMR Optimization: IT Support in a General Practice Setting

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## Abstract

*In this paper the use of an electronic medical record (EMR) system in a general practice setting is analyzed. The concept of infrastructure helps shed light on its supposed role of invisibly supporting the work practices of medical and administrative personnel. An ethnographic case study at a Canadian Community Health Center has been conducted following an action research approach. The researcher assumed the role of IT support in a situation where the EMR system was displaying technical problems after an update of the software. Her role developed from troubleshooting IT issues to EMR training and IT education, and finally she was also increasingly involved in EMR optimization. Our research provides in depth insights into the researcher's role as a mediator between the medical work and the technical tool within the larger context of system design, which, we suggest, has implications for design of programs to support the introduction of EMRs. Although those trained in health and medical informatics are aware of this need, research findings presented here suggest that this is often overlooked in funding programs and project implementation.*

**Keywords:** *Computerized Medical Records Systems; Community Health Centers; Action Research; Workplace Ethnography; Infrastructure; IT Support*

## 1 Introduction

In this paper we follow the path of a researcher who, in partnership with a Community Health Center (CHC) in Canada,<sup>1</sup> simultaneously studied and supported work practices related to an electronic medical record (EMR) system that had been in use for a few years. The software used in this clinic we studied—which we refer to in this paper as EMR\_sys in order to protect anonymity of the clinic and software vendor—was used for the management of patient-related data, appointment scheduling, and messaging between clinicians and medical office assistants (MOA). This paper reports results from a 2 year study of EMR\_sys which had as one of its

goals documenting challenges related to enhanced use of electronic records for management of patients with multiple chronic conditions.

Anchored within a socio-technical perspective, which “examines the design, uses, and consequences of information and communication technologies in ways that take into account their interaction with institutional and organizational contexts” [1, p. 217] our study was rooted in the idea that standard views of technology as tools have led to underestimations of costs and complexities of computerization and overestimates of the generalizability of systems between settings and groups and that workable systems are “supported by strong sociotechnical infrastructure” [1, p. 228]. Our research, which drew on theoretical insights from science, technology and society studies, took Star and Ruhleder's (1996) insight that information technology is often viewed as infrastructure, and taken for granted,

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receiving critical scrutiny only when it fails [2], as a starting point.

The underlying premise of our research was that the EMR system was a kind of infrastructure that is “by definition invisible, part of the background for other kinds of work” [3, p. 380]. It was supposed to be ready-at-hand so that it could be drawn upon to make enhanced use of the data gathered during patient visits. Although much popular rhetoric about EMR systems implies that the EMRs, once installed do the work [4], infrastructure studies [3] as well as scholarship concerned with appropriation work [5] and configurability [6] suggest that human intervention is often required to make such infrastructures work [5]. Our theoretical orientation suggested that as the clinic which served as our study site began using advanced features of the EMR to support management of patients with chronic diseases, that strong sociotechnical infrastructures would be required to ‘make the technology work.’ Our empirical goal was to document what was required to ‘make the technology work.’

Our research was undertaken within an action research framework. Designed to bridge the gap between theory, research, and practice [7], action research generates research about a social system while trying to change it [8]. Action research is particularly well suited to research aimed at problem solving and improvement [8]. Our action research orientation, and our research group’s commitment to making useful contributions to organizations which serve as our research partners were reflected in our research design (described in more detail below in the methods section) which embedded a member of our research team<sup>2</sup> in the clinical setting, where she could help the clinic carry out its goals of using advanced EMR features for management of patients with chronic diseases, and at the same time could document what was required to ‘make the technology work.’

### 1.1 The Research Setting

The clinic that served as our research partner and field site is a community health center (CHC) in Vancouver, British Columbia. In the CHC clinical staff (six physicians, one clinical pharmacist, and one nurse prac-

itioner) work together with the MOAs, the medical office administrator, and the executive director. The clinic also has a long tradition of employing and training students for clinical as well as administrative tasks. The CHC where we carried out our research differs somewhat from other primary health care centers. In British Columbia, most primary health care clinics are run as private businesses, on a fee for service basis, and practices can have only one doctor or a large clinic can have as many as 40 or 50 doctors. Although the size of the clinic which served as our study site and the fact that virtually all of the doctors worked less than full time was not atypical, the fact that the doctors worked on a salaried basis rather than a fee for service, and the clinic received a grant from the health authority (a regional health service management and delivery body which in turn received funds from the provincial Ministry of Health) based on the number of patients they served and the type of services they provided is not typical. The clinic does, however, represent a model of care delivery which the province would like to see increased.

The EMR system (EMR\_sys) has been used since its initial implementation in 2004 (see [9] for more information about the early years of the implementation). The clinic was one of the early adopters of EMR\_sys. At the time that the clinic began using EMR\_sys, very few clinics in the province were computerized. The clinic had received funding through an early government funding scheme to purchase EMR\_sys, and the vendor had much to gain in doing a ‘good implementation’ in that it was likely—and in fact did become the case—that subsequent government funding schemes would identify a handful of EMR vendors’ systems which were approved for purchase with government funds. As an early adopter of EMR\_sys with considerable future business riding on the success of the initial implementation, in the early days of the clinic’s implementation of EMR\_sys, technical support was quite good. However, by the time the project described here began, EMR\_sys had gained considerable market share (in part as a result of having been selected as an approved vendor under a government funding scheme in a more populated province). The EMR\_sys company had grown quickly, and technical support had, arguably, suffered.

The EMR system supports the storage and retrieval of administrative and clinical information (diagnoses, medication, lab results, etc.), the documentation of patient encounters as well as scheduling of appointments and billing. At the time of this research the clinic had already established a high level of routine in the use of the EMR system. While they started off basically keeping up documentation practices from the times when paper

<sup>2</sup>Initially this role was filled by a staff member who left the project after one year. Having processed all of her data (see methods section below), she subsequently assumed a role as a support person for the clinic. She is in the following referred to as RA1. Her role in research was taken over by the first author of this paper who within this text is referred to as RA2. As project PI, the second author has developed and maintained a relationship with the clinic, including regular meetings with senior staff, over a decade, and provided oversight of data collection and analysis.

records had still been in place they had gradually taken up some of the more enhanced functionality of the EMR system. For example, they had tailored the messaging function to their requirements, made use of automatic alerts and reminders, built-in checklists for patient education, and printouts of flow-sheets for the monitoring of specific parameters for chronic disease patients. The clinic is continuously striving to improve their practice, so adaptations are regularly made according to evolving needs. While many smaller changes were informally addressed, the clinic followed a PDSA (Plan – Do – Study – Act) approach for some of the major changes. This allowed them to try, assess and adapt or discard changes in a focused but versatile manner.

At the start of the project reported here,<sup>3</sup> EMR\_sys had just gone through a major software update. After this update several problems occurred (such as repeated freezing and crashing of the system), and some of the functions of the software had changed. Consequently, at the start of the 2 year project discussed here, instead of thinking about how to use stored data for secondary purposes the staff at the CHC had to address IT problems while struggling to keep up their work of patient care. As staff struggled with getting the system upgrade to work, the supposedly invisible infrastructure became visible. “As long as the technologies serve their designated purposes, they remain invisible to the user, but when they fail, the interdependencies among work tasks and IT tools make the infrastructure failure a primary concern of workers” [10, p. 449]. In the aftermath of the system upgrade, RA1 came to be an important resource that personnel at the CHC turned to whenever they encountered problems with the system, and through this process RA1 took on the role of IT support.

Generally, the challenges the clinic encountered with EMR\_sys could be classified as problems related to the broader hardware and software environment (e.g., driver problems, issues arising when one part of the system updated or failed, etc.), and problems related to design and use of EMR\_sys (for example, that a feature did not work as it was supposed to, or that the clinic wished to carry out a particular task which seemed like it ought to be possible, but a macro had to be written before the task could be performed). In her capacity as a technical support person, RA1 engaged in varied activities from troubleshooting to determine what the source of a problem was (which often required significant ad-

vanced computing knowledge), to writing macros, and reviewing problems identified by clinicians (e.g., when patients known to have a specific chronic disease did not appear in a search that should have yielded their name in the search results) and determining why they had occurred (in the example above, usually because the patient’s condition had been coded in the record in a manner that was incompatible with how the parameters for a search written into a macro).

Sometimes problems with EMR\_sys could be easily addressed—for example, by re-booting EMR\_sys when it froze. However, often, when the clinic encountered a problem related to EMR\_sys, ample troubleshooting had to occur before it was clear that the problem was an EMR\_sys software problem (as opposed, for example, to a problem with server software, or a device such as a printer). This was particularly true with respect to system breakdowns, and RA1 spent ample time tracking down the source of a problem, and convincing the responsible party that they (as opposed to another provider) were responsible for a fix.

The process of making changes to the EMR\_sys hence varied with the nature of the problem. Some fixes were easy and of a largely social nature (for example, when it became clear that the system had to be regularly re-booted, RA1 worked with clinic staff to make practice changes so this occurred). In other instances, RA1 wrote macros so that searches could be carried out (e.g., that all patients with type II diabetes could be identified), and in some instances, RA1 spent hours on the phone with staff—often senior staff—at EMR\_sys outlining a problem, documenting a problem (to prove it could not be fixed at the clinic), and negotiating to have a bug fix undertaken by staff at EMR\_sys.

## 1.2 Overview of Paper

This paper provides insights into the job of IT support in the setting described, which is a rather unexplored area in IT work [11]. IT support has been identified as one important factor to support the implementation and efficient use of hospital information systems (HIS) and is used as one of the performance indicators for HIS benchmarking [17]. It has been pointed out that local technical support is important within the complex IT infrastructure in hospitals [18]. Also for the primary care sector, some studies suggest that IT support is crucial, however not always in a formalized role within the organization. For example, an ‘in-house problem solver’ can be instrumental in realizing the most benefits of a newly introduced EMR system in family practice, facilitating the process of EMR adoption by developing an intimate knowledge of the EMR system and providing

<sup>3</sup>The research project reported here is the most recent of several projects members of our research group have carried out with this clinic. Our research collaboration with the clinic began in 2003, prior to the clinic’s initial purchase and installation of electronic patient record software. For additional information about this clinic and its electronic record implementations, please see [9-14].

colleagues with guidance and assistance when problems arise [19]. Community health centers use EMR systems in an effort to improve the efficiency of care delivery to an increasingly complex patient population. It has been found that in the context of EMR implementation within a network of urban community health centers “constrained organizational resources for training and ongoing IT support were widely noted as challenges that may have exacerbated, or precluded early resolution of, efficiency issues” [20, p. 807].

While there have been numerous evaluation studies of EMRs in primary care and also a few considering the role of IT support, education etc., we have found no other studies which have yielded the detailed insights we report below, about the nature of IT support required to achieve the benefits of EMRs associated with secondary use of clinical data for management of patients with chronic diseases. The strength of our findings lies in the contribution they make in rendering visible the nature of often invisible work which must be performed to achieve the benefits of advanced features of EMRs for management of chronic diseases. Our findings stress the need for IT support in health informatics settings, and can be used as a basis for developing funding policies for government programs aimed at increasing the uptake of EMRs, and can contribute to the development of job descriptions for IT support staff in primary healthcare settings.

In the next section of the paper, we provide an overview of the methods used in carrying out our study. In section 3, we highlight characteristics of IT infrastructure by following RA1 in her role of IT support in a situation where the breakdown of the infrastructure brings to light some of the tasks that are otherwise hidden to the user. Each sub-section addresses a different aspect of IT support which was required and performed in the context of ‘getting the system to work.’ We end with a discussion of our findings (section 4) and conclusions (section 5).

## 2 Methods

Research reported here has been undertaken within an action research framework, described above. Initially, a Master’s prepared research assistant (RA1) was hired to fill the position of embedded researcher, which was to consist on the one hand of providing technical support to the clinic as they attempted to ‘make EMR\_sys work’ for chronic disease management, and on the other hand, to serve as an ethnographic research assistant, documenting issues and challenges with EMR\_sys as the clinic went through the process of using advanced

features of EMR\_sys for management of patients with chronic diseases. In this capacity, RA1 documented her work (e.g., wrote extensive field notes, with her reflections on the events recorded separately), imported data into NVivo (qualitative data analysis software), coded the data, and performed initial analysis of the data. The collected data consisted of extensive observation and informal interviews that focused on documenting end user’s difficulties after the system update. An ethnographic approach was taken because it often provides “a much better means of anticipating the dynamic effects on work organization” [21, p. 21]. RA1 was present at the CHC for 9 days a month on average, over 9 months from August 2008 to April 2009. After that period, RA1 was still available for clinic personnel as an IT consultant on a contract basis until she finally left that role in July 2010.

In the second phase of the study that started in July 2009 the first author of this paper (RA2) carried on with the research.<sup>4</sup> She continued to do participant observations of the work practices at the CHC and was present at the CHC for four days a month on average, over eighteen months until December 2010. She used the data collected by RA1 and undertook a second cycle of analysis, performing her own coding of the material in NVivo to get a thorough understanding of the research that has already been performed and carry on with the analysis. As the technical issues with EMR\_sys had become less and RA1 kept on providing IT support to the CHC, RA2 was able to get back to the original focus of the research project in her work, i.e. the enhanced usage of the EMR system for chronic disease management. In that respect she performed participant observations of work practices of doctors using the system and of staff meetings. Observation protocols were entered into NVivo and coded together with the previously collected material. Additionally, to capture the opinions and experiences of medical and administrative staff, between April and October 2010 RA2 conducted qualitative interviews with four of the six doctors in the CHC, the clinical pharmacist, the nurse practitioner, two of the MOAs, the executive director, as well as with RA1 to include her reflections of her role as IT support. These interviews covered both topics, issues of IT support as well as the secondary usage of EMR data for chronic disease management. The interviews were recorded and transcribed verbatim. They were also entered into and coded using NVivo.

Research reported here draws on the observation

<sup>4</sup>In the following text that focuses on the tasks of IT support, any mention of “RA1” refers to the first researcher who filled the action-researcher role, and not to the first author of this paper (who is referred to as RA2).

notes taken by RA1 including her comments on experiences in her role as IT support person, and on the interviews that have been conducted by RA2. Citations from the material that are used below are coded OBS and provide the date of the observation (for observation notes taken by RA1) and INT (for quotes from transcripts of interviews conducted by RA2). Interviews used include those with three of the doctors (DOC1, 4, and 6), the executive director (EXDIR), the clinical pharmacist (CP), and RA1. Extensive quotes from the collected material (reflections of RA1 in her observation notes as well as excerpts from interview transcripts) are provided in the following as to give the study participants a voice and reflect their experiences and bring them 'alive'.

### 3 Results

During her time at the CHC RA1 undertook several tasks that can roughly be grouped into three categories of 1) IT troubleshooting, 2) EMR optimization, and 3) EMR training and IT education. IT troubleshooting referred to dealing with all kinds of technical problems like the freezing of the system, whereas EMR optimization was more focused on improving the software as a tool, for example by making requisitions easier. Asked about the changes of her tasks over time, RA1 answers:

"I think when I first started there it was more IT support because when I first got there they had just gone through an upgrade. And so a lot of it was [...] troubleshooting issues of their upgrade. And then after a while [...] they became more comfortable with the upgrade and those issues did not come up as often. [...] My IT support I guess became more EMR optimization. [...] Doctors would come up to me and ask 'Can the EMR do this?' [...] And often it could and they just did not know that it could. And so then I could show them how" (INTRA1 0428).

When her role as a researcher at the clinic ended, RA1 continued supporting the personnel on a contract basis in what she described as the role of an IT consultant. While the office manager took over a lot of the troubleshooting tasks she had performed in her capacity as action researcher, and one of the doctors took on the endeavour of EMR optimization, they both referred back to RA1 when they needed her input. It was not clear however who would be in charge of the training or education about the EMR and its functionality in the absence of RA1. Tasks associated with ongoing education about the EMR and the whole IT infrastructure had been taken on more informally, in response to the need of the clinical personnel to understand the software and

its capacities, and also to keep up with changes after upgrades. In the following these three sections, each of the categories of tasks—IT troubleshooting, EMR optimization, and EMR training and IT education will be described in greater detail.

#### 3.1 Troubleshooting IT issues

In her role as an IT troubleshooter RA1 was confronted with a growing number of technical problems around EMR\_sys and the IT environment in which it was embedded. Her tasks included logging issues which arose with EMR\_sys; figuring out and understanding problems; finding solutions; communicating with the vendor and other parties; and communicating the status of issues back to users. Each of these roles is explicated below.

**Logging issues** The CHC is staffed by medical and other health practitioners and administrative staff, none of whom had been given the task of managing or maintaining the EMR. Hence, RA1 became the contact point person when problems with EMR\_sys were encountered. Personnel turned to her when the system crashed, when they were not able to log on or when they could just not get their work done because EMR\_sys was not providing the service it was supposed to provide. RA1 described how the personnel at the CHC would come up to her and tell her about issues that they felt should be reported to the software vendor. She says that she collected them and started to keep a spreadsheet of issues that were reported to her (INTRA1 0428).

Many of the issues were communicated to RA1 while she was at the CHC. However as she was not continuously present in the clinic (because her job comprised both action—in the clinic—and research—at the university) people would also turn to her by e-mail and occasionally by phone. A specific e-mail account was set up in the messaging system that was called "EMR\_sys issues" with the idea that it would provide a mechanism for capturing problems with the system, and communicating those problems to RA1 who would then have a record of the problems. The EMR\_sys issues e-mail account on the one hand served as an action list for the technical support tasks that needed to be done, and on the other hand ensured that the issues that arose and needed to be addressed were captured for research purposes.

While RA1 was originally supposed to deal only with problems that were related to EMR\_sys, she was increasingly confronted with more general technical issues that had to do with the hardware setup, transmission of documents between systems, or the configuration of user accounts that arose in relation to the broader environ-

ment in which the EMR\_sys system was installed and operating. This may be due to the fact that for the personnel at the CHC it did not make a difference if the problems were related to the software or to other components of the system—if a problem arose that interrupted their work practices, they saw it as an EMR\_sys problem, and it was often initially unclear to the end user whether the origin of the problems was hardware, software, configuration, or some combination of all of the above. In addition, because no clinic staff member was responsible for technical support, RA1 became the most visible face of technical support in the clinic.

**Figuring out and understanding problems** The CHC personnel approached RA1 with different kinds of issues. Sometimes they were related to the same underlying problem (e.g., the system being slow and freezing because they were running out of storage space on the server). On other occasions seemingly related problems were actually different. So RA1 not only logged issues but also had to think about possible sources and understand the problem at hand in enough detail that she could either solve it herself or communicate it to the responsible actors accordingly. This was often challenging because it typically was not clear where in the system—in hardware (e.g., the network or a client), or software (e.g., due to a bug or problem with a setting)—the problem existed. Consequently, figuring out and understanding problems required RA1 help people at the CHC formulate problems such that both she and clinic staff could understand. She did this for example by taking the time to talking through problems with the staff and asking clarifying questions. RA1 reported about the relief that this way of dealing with problems provided for the personnel.

RA1 had to develop intimate knowledge of EMR\_sys and the functionality it offered as well as the interactions with other software and hardware components. She used EMR\_sys herself and tried to reconstruct errors that occurred, or she explored the system by working on fake patients that had been created for that purpose. She consulted the online help forum of the vendor and checked on the internet for insights about more general technical problems. She performed what has been called ‘diagnostic work’ [22]. “When faced with anything out of the ordinary, faulty or suspicious, the work of determining and categorising the trouble, and scoping for what to do about it (if anything) often go hand in hand” [22, p.110].

RA1 talked about the hardware issues the CHC was facing when she first arrived there. Confronted with the system being slow and freezing repeatedly, she had to figure out what actually caused the problems. She says that at that point the hardware provider came into the pic-

ture. It would happen occasionally that RA1 would be directed back and forth between the hardware and EMR vendors when she reported a problem. RA1 indicated that in such cases she tried to understand the problem more by collecting additional information about the specific circumstances under which the problem occurred. Once she felt she had enough details she would communicate them to either the hardware or software provider (INTRA1 0428).

**Finding solutions** The range of attempted and successful solutions was as big as the range of the problems that RA1 was confronted with. On some occasions shutting down and restarting the system or adjusting system settings would help. For problems related to EMR\_sys RA1 first had to find out whether it was a bug in the software or a user problem, i.e. a mistake caused by the user not doing things as they were supposed to be done. In the latter case RA1 had to find out how to do things properly and communicate this to the user. Problems that occurred which were unrelated to user behaviors had to be communicated to the vendor of the software or other responsible parties (see below).

However for unresolved problems that were awaiting solution there was also the option of finding workarounds. So part of the role RA1 assumed as a technical support person was identifying how the task at hand could be carried out by means other than those originally suggested. Field notes include reports about several such occasions where workarounds were sought and developed. In one case, once a workaround had been developed, RA1 reported her way of temporarily solving a problem back to the vendor, which ended up being the solution which the vendor used for others as well (OBS 0902).

**Communicating with the vendor and other parties** A big part of RA1’s tasks involved communication with the software vendor. One reason RA1 would contact EMR\_sys was to find out about known issues. She would either check their web forum or call them early on in the process of figuring out problems. However sometimes it would take her longer to identify the source of a problem (OBS 0902). One of the challenges faced by RA1 was to figure out which party to turn to, for example, if a problem is caused by the hardware, EMR\_sys, or other systems like the software used to transmit results from laboratories. So on many occasions RA1 had to turn to different actors, mainly by phone, to either find out about the hardware setup (OBS 0911), or to track down individual issues to understand what had happened on both sides of the data exchange with a laboratory. Hence one of her roles was to identify and diagnose system configuration problems, which it has been suggested warrant greater attention as tech-

nological and organizational environments into which computing systems are introduced become increasingly complex [6]. RA1 developed ample expertise in this regard. Eventually she became the person the technical support person who was helping the CHC with their network would turn to with questions about their system. She said that she could often explain problems to him better and had a better understanding of the clinicians' needs (INTRA1 0428). Clearly, over time, RA1 became an intermediary between clinic EMR users and the network of actors who contributed to the ongoing maintenance and support of the clinic's EMR system.

The main contact in this process was EMR\_sys. When reporting a problem to EMR\_sys, RA1 would provide as many details as possible, such as the specific patient, the specific actions taken by the clinician, or the specific circumstances under which the problem occurred. She would be asked to provide screenshots, or she would go through issues step by step with customer support on the phone while they were having remote access on a shared screen (OBS 0904). Once an issue had been identified as related to EMR\_sys (i.e. other sources including the hardware, other systems and the user had been excluded as a cause of the problem), a case was created with a case number by EMR\_sys so that both parties could follow up on it. RA1 found herself increasingly in the role of keeping track of a number of issues, calling and e-mailing the customer support at EMR\_sys to ask about the progress of a situation. The number of issues grew to such a level that it was decided to do a conference call not only with the customer support provider at EMR\_sys but also her supervisor (OBS 0911).

Another set of issues was related to problems of data exchange between EMR\_sys and the provincial CDM toolkit that the CHC was using.<sup>5</sup> In an effort to resolve these problems, RA1 also communicated with representatives of the provincial practice support program (OBS 1030). Through her involvement at the CHC RA1 had established relationships with all the involved actors.

**Communicating back** Another important aspect of RA1's role at the CHC was to communicate the results of her investigations back to clinic staff. Follow up about specific problems where only specific staff were concerned occurred. In addition, general information about how to do things properly in EMR\_sys or about workarounds RA1 had figured out that were relevant for all the staff also needed to be communicated. For these RA1 would either use the messaging system to write a mass communication or she would address the issue at

a team meeting.

RA1 also passed on important information about the feedback process with the vendor. She reported that when she was reporting about the progress that has been made in clarifying problems staff was thankful to learn from her about how submitted issues were dealt with by personnel at EMR\_sys (OBS 0904). Clearly, an important part of technical support is reporting progress in addressing issues back to staff, who often mistake a lack of communication from technical support staff for neglect.

In terms of troubleshooting IT problems RA1 was the main contact point for collecting and keeping track of issues that disrupted the use of the EMR system. She worked as a mediator between the personnel at the CHC and other parties, especially the software vendor. One of the doctors at the CHC emphasizes the importance of having someone to keep track of things and follow up with the software vendor (INTDOC4 0901). In that respect RA1's role was not only to get the system back to work technically, but also to restore the trust of users in the system. Another doctor described the role that RA1 has taken on as hugely helpful "just in terms of troubleshooting these little software issues that come up" (INTDOC6 0922). She said that this is why it was important to have an IT person who was there to figure things out, and get them back to work "so that we can continue to have confidence in it" (INTDOC6 0922).

### 3.2 EMR optimization

RA1 also performed tasks of EMR optimization, i.e. the adaptation of the software and its features that are used to support mainly routine tasks. Many of the questions that RA1 received from personnel at the CHC were not related to things that were not working or problems that occurred, but rather were related to finding alternative ways of using the system that would make the accomplishment of tasks easier for the staff—this process is sometimes referred to as the appropriation of the system by the users [5]. Some of these requests referred to EMR\_sys. In these cases RA1 would look into the software, check help files and the online forum to see if EMR\_sys supported the requested functionality (such as linking health information websites to problems, or sending follow-up request for pap tests directly to an MOA so that the list of follow-up tasks would not be populated, or setting up groups of users to be addressed within the messaging system for specific purposes). Other requests could be dealt with by easy adjustments of the system (such as changing the display settings to make scanned documents more readable, or creating shortcuts to certain folders on the desktop). A

<sup>5</sup>Interestingly, problems with communication between the EMR\_Sys and the provincial CDM toolkit dated back to the initial release of the EMR\_Sys, and had never been fully resolved [9].

tool that RA1 developed and that was much appreciated by the personnel at the CHC was a table summarizing shortcut keys for copying and pasting. On one occasion RA1 changed the font size in a document template from 8 to 12. Prior to that the clinician had to change it herself each time she used the template. RA1 remarks that these are simple ways to make the practice easier (OBS 1014). In such circumstances, RA1—acting as technical support person—sought and found technical solutions to practice wide problems which required knowledge of general computing environments (e.g., the concept of templates and how to alter them in a networked computing environment) which exceeded the technical knowledge of front line medical staff.

RA1 was also involved in tailoring EMR\_sys to the needs of physicians' and MOAs' work practices by setting up or modifying existing functions, including handouts and requisitions for patients, templates for the documentation of patient encounters, practice searches, and rules that would incorporate guideline based care into the EMR. These are described in more detail in the next section.

**Teaching tools and handouts for patients** Examples include flow-sheets for the management of chronic diseases as well as other handouts and teaching tools for patients. These are used to show patients their progress. Links are provided from within the chart to these documents, so that they can easily be printed out and handed over to the patient (INTRA1 0428). Using the input of the clinical pharmacist who coordinates group visits for chronic disease patients, RA1 changed and optimized the flow-sheets that were generated by EMR\_sys, especially those for diabetes. One of the doctors added that they had also generated a second page that patients can use to write down their own values. She says that this is an effective tool to enhance patient involvement and encourage self-monitoring which reportedly leads to better health outcomes (INTDOC1 1005).

The templates RA1 created also included action plans for asthma and COPD (chronic obstructive pulmonary disease). One doctor commented that these are linked to care guidelines. Again they were used as teaching tools, which provided patients with a quick and easy overview of things to check for and steps to take. They are individualized for the patient, i.e. the patient's information is taken from the EMR, including the patient's medication list. The clinical pharmacist added that this had cut down on their workflow as before they had to manually fill in the information in a paper sheet and then scan it (INTCP 0927). She added that it took a few runs to get it right, but she was happy that RA1 was able to do it as it needed "a little bit of tricking. And that's something I don't have the skill set to do, and I don't

really want to have to learn that" (INTCP 0927).

**Requisitions** To support the work of the clinical personnel RA1 was engaged in the setup of forms for requisitions that would automatically be populated with the patient information and the information about the clinician who was requesting the specific test or exam. One of the doctors explained that these are requisitions that they frequently use from various providers requesting x-rays or ultrasounds for example. She added that they have made their own school absence note, massage therapy letter, and physiotherapy letter, which are all automatically populated with patient data saving them a lot of time (INTDOC1 1005). The information is also automatically saved into the EMR and labelled by keywords so that it can easily be retrieved. Most recently they have created a template for a standing order. This is most helpful for patients who repeatedly need the same orders (mainly chronic disease patients).

**SOAP templates** Another endeavour that RA1 was engaged in was the creation and modification of SOAP templates. SOAP refers to "subjective, objective, assessment, plan" and provides a structure for entering data about a patient encounter. The templates can be set up for specific diseases and work as a reminder of what information should be included in the records. Although the clinic does not use many of these templates, a few are frequently used, such as the template for a pap test or the so called Rourke template which includes well baby checks for specific aged infants: two, four, six, twelve, and eighteen month olds.

**Practice rules** RA1 set up and implemented practice rules. Practice rules are used to identify patients who are due for tests, or for the screening of patients for preventive measures. Once a rule is implemented a reminder will show up on the charts of those patients to whom the rule applies, for example if they have not had a pap test done for more than a year. One of the doctors described how she asked RA1 to work on a system to implement a FRAX (fracture risk assessment) rule. She explained that this involved creating the rule so that it worked and it showed up with the appropriate parameters. She added that it was also important to make sure that some patients were excluded, for example if they had declined a test in the past. She said that she had passed this on to RA1 as this exceeds her involvement with the system and its functionality (INTDOC4 0901).

**Practice searches** Finally RA1 was also involved in what had originally been envisioned as one of her main tasks: supporting the secondary use of EMR data. In this capacity, she created and helped organize a system of practice searches that would allow the clinic to track their performance in what they refer to as a "quality dashboard" [23]. The practice searches can be used to

scan specific patient panels (e.g. those with chronic diseases) and provide information about the quality of care that they receive. For example, guideline compliance can be measured by evaluating the percentage of diabetes patients who follow up on recommended regular testing. The executive director described how this endeavour took up a lot of their resources in their effort to figure out how to set up the searches and how to assure that the data were available in a format that enabled them to gather the information about their patients which they actually wanted.

“So I would say, the first year or two even of doing practice searches what we learned probably more about was the actual IT side of things, not the patients” (INTEXDIR 0901).

Again RA1 was engaged in this process of learning and understanding the enhanced functionality of the EMR system. Finally she was able to perform searches as requested by the clinicians. As the clinical pharmacist reported “that was the joy of having [RA1]: I asked her for the search, and she built it. So I just had to go and use it” (INTCP 0927).

After RA1 had left the CHC one of the doctors carried on her tasks in terms of EMR optimization (except for the use of practice searches and rules) for clinical use. Before RA1 left, she had a meeting with the doctor in order to pass on any information that would be helpful. Reflecting on whether or not it was appropriate for a doctor to solve these types of problems, the doctor concluded that clinician input is needed to be able to optimize EMR usage, so the ideal to her would be a team of a clinician and an IT person like RA1 (INTDOC1 1005).

### 3.3 EMR training and IT education

EMR training and education not only about the software but the computer system as a whole formed another part of RA1’s tasks that she had taken on over the time of her involvement with the clinic on a more informal basis. Even while performing tasks that can mainly be characterized as troubleshooting (see above) RA1 actually also helped people understand the logic of the EMR in terms of its functionality and its interactions with other systems by communicating solutions back to them. She helped CHC staff figure out things on their own, learn how to deal with the system, and get comfortable in using basic functions, which is also a prerequisite for the personnel to develop ideas about more advanced uses of the software. On many occasions RA1 explained the system to the users, in response to their need to understand what was going on with the system. This played a critical role in helping users maintain their trust in the

system when they were facing technical problems. One of the MOAs commented “I have the medical experience, but not the engineering or the technical so I don’t know why things happen” (OBS 0819). As described above RA1 would sit with the personnel in front of the computer and either try to figure out what the problem actually was or explain to them how to use the software to avoid problems. After RA1 had been at the CHC for a few months she noticed changes in how the personnel would communicate problems to her. In her notes she reflected that it is interesting to note that doctors increasingly provided possible reasons along with the problems that they presented to her. She noted “Before it has usually been a big unknown as to why the problem exists” (OBS 1121). She cited the clinical pharmacist who told her upon asking for help “not by choice, but I’m starting to understand more what the errors mean. I’m not panicking anymore. I think I know what I did wrong, but maybe you can come up and take a look” (OBS 1209).

Overall RA1 noticed that over time, personnel were becoming more concise about problems they were reporting to her and in communicating with her, there was increasing evidence that CHC staff were starting to understand how the software worked. As a consequence staff were more confident about the system and in their use of it over time, they blamed themselves and worried about having done something wrong less often.

Although this was not one of her official tasks, RA1 also trained people who were new to the system by showing them how to do things when they needed help. RA1 also showed staff how to use new features of EMR\_sys. She remembered being approached for help by staff while sitting in the charting room. She had access to EMR\_sys, so that she could learn about it and get comfortable with it herself. She explained that this allowed her to answer people’s questions when they did not remember how to perform certain functions or when they were wondering about changes in the software. RA1 says “I gained their trust as someone who knows how to use the EMR” (INTRA1 0428). On other occasions RA1 felt that it was necessary to learn more about the tasks of the personnel to be able to decide how they could be supported by the EMR\_sys. People also turned to RA1 when they tried to figure out how they could get things done more easily. Finally they turned to RA1 when they wanted to accomplish a new task and were wondering if this was possible within EMR\_sys. Through her work at the CHC RA1 learned about the software, but she also had to develop knowledge about the needs of the users and gain a detailed understanding of the tasks of the medical and administrative personnel, and how they were performed within that clinical

context.

After RA1 left the CHC it was not clear how her expertise could be preserved. A training session with the software vendor was organized, in which RA1 participated. She used her own knowledge, training documents that she had developed before, and placed these together with information from the training session with the vendor and made this information available to the personnel at the CHC through their computer desktops. One of the doctors created an icon labelled “EMR\_sys clinician tips”. The doctor indicated that because they knew she was leaving, the clinic invested time and money into having her generate this information, as they did not want to lose all the knowledge that she had gained, especially about features that are not frequently used (INTDOC1 1005). She spoke about the difficulty of disseminating information to everybody as their meeting times are limited and their work days are very busy. This is an ongoing issue, as the need for training to use the EMR and its functionality is a continuing task, because on the one hand the software changes after upgrades and on the other hand the needs of the clinic change as they explore new ways of making use of the EMR. At the time of the interview it was not clear how this ongoing need for training would be met after the departure of RA1.

In RA1, the CHC had a person who had an understanding of the EMR system as well as of the tasks of the medical personnel. There is a real need for a person in this role, mediating between the software and the work processes the software should support. As the clinical pharmacist pointed out

“Because there is so much about the system that we don’t understand and know the potential for. And it’s frustrating because we are doing things the hard way. And not knowing that there is an easier and more efficient way to do things is the problem” (INTCP 0927).

One of the doctors added that someone should be in charge to keep up with the training and dissemination related to system updates. She felt that they themselves do not have the capacity to read news about updates, so they need someone who is dedicated to looking through new functionality and educating doctors and other clinic staff about those features that might actually help them in their practice. This doctor felt that this would have to be an expert user of the system, as this person would have to have a detailed understanding of how the system is actually used by the doctors (INTDOC4 0901).

## 4 Discussion

The paper introduced the case of an EMR system that after a software update did not work in the way it was supposed to, as part of the mostly invisible infrastructure supporting work practices of a group of family physicians at a CHC. Although it may be tempting to conclude that we simply conducted an action research oriented study of a researcher turned EMR support person at a community health center that struggled due to a poorly implemented upgrade to the EMR, such an assertion trivializes the importance of invisible work in maintaining computing infrastructures [15], and glosses over the frequency with which some of the other phenomenon we observed occurs. Neither researchers nor staff at the CHC experienced the EMR upgrade as a poorly implemented upgrade. In contrast, it was experienced as a typical upgrade—an upgrade that was well planned (for example, it was done over a long weekend so problems could be addressed in the absence of the pressures of the clinical workflow), but where in spite of all of the clinic’s planning, problems and challenges arose. Some of those problems (e.g., that after the upgrade, macros used to conduct practice searches had to be re-written) were known by the vendor, and yet nonetheless a decision was made to move forward in a manner which was problematic for the clinic. Though it would be easy enough to suggest that the vendor did a bad job, a simple dismissal of the vendor’s behaviour detracts attention from a larger phenomenon—that as software is changed and new versions come out, some work practices are favoured and others are not, and this process has very real consequences for a company’s installed user base. Arguably, the CHC we studied was disadvantaged because it was an early adaptor of the technology, and, as such, had to absorb costs associated with accommodating the vendor’s changes, as the vendor sought to improve their product.

The paper has also explored the role filled by an action researcher providing IT support in this situation. From our examples, we have seen that once the problems with the update were managed and the personnel had gained trust and a better understanding of the system, the focus of RA1’s tasks changed from IT support to EMR optimization. The tasks of IT support and software enhancement are often closely related as they both necessitate a thorough understanding of the system. As reported by others, the support service can be used to gain feedback from users and input not only for error reports, but also for change proposals [24]. While providing IT support, RA1 had also taken up the role of a trainer for the software and the broader IT infrastructure. This wide array of tasks is in line with what is described

elsewhere as the tasks of tech support workers that range from fixing immediate, low-level problems to consultancy for longer term projects [25, p. 191]. While some of the tasks that RA1 has taken on in the CHC might be transitional, other tasks she undertook highlight the processes that are needed to keep IT infrastructure running in the context of changing needs and changing constellations of providers. A person dedicated to IT support turned out to be especially helpful to the CHC in their aim to make enhanced use of the system and the patient data stored in the EMR. The medical personnel do not have the time or skills that are necessary to engage with the software on a level that would allow them to achieve these tasks unaided.

A few remarks have to be made about the software that the CHC used and their relation with the vendor of the software. The EMR system has been in use since 2004. Early in the EMR adoption and implementation process, there was a fairly close connection between the clinic and the vendor of the software. However, by the time research reported here was carried out the EMR company had grown and the personnel at the clinic felt that the support had gotten more detached. Clinic staff had become more sophisticated users of EMR\_sys, and they felt that often their questions were very specific and could not always be answered by the call centre personnel. This issue—of whether or not rapidly growing companies can adequately manage varied technical support needs of new and mature users—is a whole different story that is worth exploring in more detail, however it is beyond the scope of this paper. It also hints at the importance of the initial decision for a particular product that often has to be made on the basis of limited information. The shopping and the tailoring of software are two main points where especially in small companies the users are involved in the “design” of software [26]. Tailoring refers to the “fitting of purchased technology to the local work situation” [26, p. 205] and it is mostly limited to the options provided within the purchased software. Although the shopping decision is obviously an important factor which shapes subsequent use of an EMR system, the focus here is on the tailoring activities that the CHC had to go through to make the EMR system work for them.

Two major roles of IT support and EMR optimization can be identified: First, RA1 worked as a mediator between the medical work and the technical environment. The medical and administrative personnel at the CHC were focused on their respective tasks, which are carried out in an environment of constant time pressures. RA1 in her role as a technical support person took away the burden and inconveniences of dealing with technical problems by acting as a point person for any IT related

concerns. Additionally she provided relief by helping clinic staff understand the EMR system and why certain problems occurred. She helped deal with the fear of doing things incorrectly and causing problems, and she helped reconcile trust in the system in a situation where the service was continuously interrupted. On another level and later on in the process she supported personnel to make repetitive tasks easier, and enhance secondary usage of EMR data. RA1 described how she saw her role mainly as “relationship managing”, mediating between the clinic and the software vendor. She spoke about how she understood that the vendor had other clients to serve, but at the same time the personnel at the CHC had issues that they needed addressed or expected to be solved right away. In her own words: “The vendor and the clinic are two different fields that speak different languages. And so you need a position in the middle that can translate. Because you see the vendor world, [...] they really speak a computer programming language. And they develop this great software with all these great functions and tools. However, maybe only half of those tools are actually usable in the clinical field. And you see the clinic and they love what they are doing with the software [...] but they wish it could do so many different things” (INTRA1 0428).

Second, RA1 was also a mediator in the bigger context of system design. By maintaining relations with actors such as the software vendor, hardware support staff, laboratories, and representatives of the health authorities, she became a mediator in the system design process. She provided multiple actors with feedback about the use of the EMR system in a specific site; and she reported about problems encountered on a very detailed and specific level which allowed actors to take steps to ameliorate the problems. RA1 commented that besides helping the CHC make use of the EMR and helping the vendor understand the problems of users, she also saw the information that she had gathered as useful at a policy level. For example, she talked about possibly limiting the frequency of system upgrades as a strategy for managing constant change at the clinical level, and how her work had shed light on the need to further develop standards, for example, to govern the transmission of lab results.

To be able to fill these roles RA1 had to acquire knowledge about a variety of things. She had to learn about the work practices within the clinic to understand the needs of the personnel. She had to learn to use EMR\_sys and what functionality it offered in order to understand what was possible within the specific software in use. She had to learn about the system setup in order to understand interactions between different hardware and software components, and finally, she had

to learn about each of the actors involved in the system implementation, and their roles, in order to understand who was responsible for which aspects of problem resolution. She has performed what others have called “participatory IT support” [16] with the characteristics of “relating the system to the use practice” [16, p. 89] and “translating between different practices [...] opening the way for ‘why-questions’” [16, p. 89]. RA1 suggested that there were two main important skills that she had to develop in her job: one was listening and understanding the problems or needs of the personnel, and the other one was explaining the process or software functions to clinic staff in a way that would allow them to understand what was possible (INTRA1 0428). The combination of research and action proved to be especially helpful, and was seen by RA1 as providing a huge benefit. Being present at the clinic and being involved in the tasks of IT support provided her with the opportunity to “almost experience it the same way that they experience it” (INTRA1 0428). But at the same time in her role as a researcher she was forced to remove herself from the clinical situation and reflect on possible improvements. She said that this helped her to look at the bigger context of system design and implementation, and by that in turn helped her be an efficient troubleshooter (INTRA1 0428).

The doctors at the CHC are busy with their day-to-day clinical concerns, so they do not have the time to figure out problems or try to find ways to optimize the use of the software. They emphasized the importance of having someone who is dedicated to these tasks. Their ideal would be a combination of a person who is highly trained in IT and knows about the features of the software, but who is at the same time a “super-user” of the software, i.e. who uses it in his or her daily work almost like a physician or MOA would use it. This confirms the importance of the need for IT support staff in clinical environments having a thorough understanding of the work processes to be supported by the software. At the same time clinic doctors stated that no matter how knowledgeable an IT support person was, that there would still have to be someone to oversee the role of the IT person and to communicate the goals and needs of the clinic from a medical perspective.

## 5 Conclusions

While many studies compare the differences in work practices between paper based and computerized medical records and investigate the initial implementation of EMR systems, little attention has been paid to the work that is needed to keep the infrastructure of an

EMR system running in clinical settings, where software and staff are constantly adapting to changing needs. As has been the case in the setting described here (in this case, largely dictated by government funded EMR adoption programs), emphasis is placed on hardware and software acquisition, rather than the tasks of troubleshooting IT issues, EMR optimization, as well as EMR training and IT education. The EMR system that we have investigated in this case study can be thought of as infrastructure with two important characteristics: its embeddedness, i.e. it is “sunk into and inside of other structures, social arrangements, and technologies” [3, p. 381] and its scope, i.e. it “has reach beyond a single event or one-site practice” [3, p. 381] in that it is being used to support family practitioners throughout Canada. Our case study suggests however that the achievement of both the embeddedness of the system, and the ability of the system to reach beyond a single doctor, practice or site is enormously dependent upon the often undocumented labour of technical support personnel, who must perform a range of tasks in order for such systems to achieve infrastructural status. Although the existence of these phenomena in our study setting do not yield new insights, they serve as a graphic reminder of how much work remains to be done in finding ways to address and support the challenges associated with achieving infrastructure.

This case study contributes to the research about the specifics of IT infrastructure in general and EMR systems in particular. Versatility and reflexivity have been identified as main distinguishing features of information and communication technology (ICT) infrastructures [10]. “In an ICT-based infrastructure, an additional reflexive level is possible that traditional infrastructures could not provide. As Castells has repeatedly shown, information systems can form reflexive infrastructures, in the sense of tools that can mediate their own further development” [10, p. 454]. This phenomenon has been observed in the case presented here, as evidenced in the two important aspects of RA1’s role as mediator between clinical and technical actors. On the side of the users of the EMR system an understanding of the tool in ample detail is needed to be able to use the EMR to its full potential and to decide what can and what cannot be achieved with its aid. Familiarity with the system is a prerequisite for the enhanced use of the EMR’s features. Our case demonstrates how co-evolution of systems and users occurs, and our empirical work suggests there are important gains to be made in finding ways to support this co-evolution of systems and users. “Once people gain proficiency in system usage, they would like to use the system in different ways and need different interfaces than those they required when they were novice

users” [27, p. 144]. This suggests that there is an ongoing need for system appropriation work. As users’ needs change, they make new and different demands on computing environments, often in an environment where hardware and software are being continuously upgraded. This constant fluctuation demands ongoing attention to configuration, appropriation, and technical support to insure that end users experience the EMR system as infrastructure.

On the side of system developers (in the broader sense, not only including the software developers but also others involved like cooperating partners, e.g. from laboratories, hardware support, or the health authorities who may set policies for using EMRs), an understanding of the variety of specific local work practices and settings is needed. Such an in-depth understanding is required to support the design of configurable systems that can be appropriated by the users according to their respective needs [6], through an understanding of which parts of the system should be tailorable. However the extended tailorability of systems underscores the need for a thorough understanding of the system to support tailoring, and hence continue the design of the system in use [28]. As outlined by others it is often hard for users to understand how a system can be tailored [29]. Tailoring is thereby a continuous process. It is “triggered by both, the introduction of a new system version and non-anticipated needs emerging during a system’s use” [29, p. 253]. A high level of expertise is needed both in terms of the IT system and the customer organization as described for example for the customization of enterprise resource planning (ERP) systems [30]. The work practices of medical personnel, i.e. a focus on the care process and a lack of time for additional tasks, speaks to a need for the involvement of a mediating actor who understands both the tasks to be supported and the EMR system as a highly versatile and flexible tool.

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