The Impact of End-user Support on Electronic Medical Record Success in Ontario Primary Care: A Critical Case Study

by

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A thesis submitted in conformity with the requirements for the degree of Master of Information

Faculty of Information
University of Toronto

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Abstract

Although end-user support is an important aspect of EMR implementation, it is not known in what ways it affects EMR success. To investigate this topic, a case study of end-user support for an open-source EMR was conducted in an Ontario Family Health Organization using 7 semi-structured interviews based on the DeLone and McLean Model of Information System Success. Second, documentation for an open-source and proprietary EMR was analyzed using Carroll’s Minimalism as a theoretical framework. Finally, themes from this thesis were compared and contrasted with a multiple case study that examined support for a commercial EMR in 4 Ontario family health teams.

Main findings include the role of informal support, which was important for ensuring that data are documented consistently, which in turn enabled information retrieval for providing better preventive care services. Also, formal support was important for mitigating problems of system quality, which had potential implications for patient safety.
Acknowledgments

I would like to begin by acknowledging Prof. Aviv Shachak, whose dedication and application of scientific reasoning to the field of health informatics is truly commendable and much needed in today’s health care industry. Without his kindness, knowledge, guidance, and seemingly infinite patience this research would not have been possible.

Credit is also due to Catherine Montgomery, for whom it was a great pleasure to work with as a research assistant at the Institute for Health Policy, Management and Evaluation. Her friendly support during my first interview and assistance with ensuring the trustworthiness of findings from this study are greatly appreciated.

I would also like to extend my gratitude to Prof. Kelly Lyons for sharing her time and expertise as the second reader of this thesis. Gratitude is also owed to the other members of my defence committee, namely Dr. David Wiljer and Prof. Choo.

Lastly, I would like to extend my inmost gratitude to my dear father whose love and character inspired me to believe in myself, attend university, and become the person I am today. I can’t thank you enough dad.
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<td>EHR</td>
<td>Electronic health record</td>
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<tr>
<td>EMR</td>
<td>Electronic medical record</td>
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<tr>
<td>FHO</td>
<td>Family Health Organization</td>
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<td>FHT</td>
<td>Family Health Team</td>
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<tr>
<td>HIS</td>
<td>Health information system</td>
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<td>HIT</td>
<td>Health information technology</td>
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<td>IC</td>
<td>Information center</td>
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<td>IS</td>
<td>Information system</td>
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<td>IT</td>
<td>Information technology</td>
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<td>MIS</td>
<td>Management information system</td>
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<td>OS</td>
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1 Introduction

Health information systems (HIS) such as electronic medical records (EMR) are becoming essential tools for managing the complex demands facing today’s modern health care system. The National Alliance for Health Information Technology (NAHIT) defines an EMR as “an electronic record of health related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization” (NAHIT, 2008, p.6).\(^1\) In addition to their functional capacity to integrate electronic prescriptions, test ordering and decision-making systems (Gagnon, Shaw, Sicotte, Mathieu, Yvan, et al., 2009), the potential benefits of adopting EMRs include: enhanced clinical productivity, facilitating coordination of care, improved health outcomes and patient safety, reduced costs and better access to care (Byrne, Mercincavage, Pan, Vincent, Johnston, et al., 2010; Car, Black, Anandan, Cresswell, Pagliari, et al., 2008; Chaudry, Wang, Wu, Magloine, Mojica, et al., 2006; Hillestad, Bigelow, Bower, Girosi, Meili, et al., 2005; Lau, Price, & Keshavjee, 2011; Ontario MD, 2010). Chaudry’s et al. (2006) systematic review which examined the impact of health information technology (HIT) on the costs, efficiency and quality of health care identified three major actual benefits: 1) improved monitoring and surveillance 2) a decrease in prescription errors and 3) better adherence to clinical guidelines. Since ambulatory care is considered by many as patients’ first point-of-contact with the health care system, the potential benefits of using EMRs at the primary care level are innumerable and far-reaching (Torda & Scholle, 2010).

There is also a significant and by-partisan political will behind the adoption and use of EMRs. On behalf of the Commission on the Future of Health Care in Canada, Romanow (2001) reports that “good information systems are essential to a high quality health care system. They allow

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\(^1\) Unlike EMRs, which are managed by a single health care organization, electronic health records (EHR) are typically managed across multiple health care organizations (NAHIT, 2008). The terms EMR and EHR (among other variations) are often used interchangeably in the literature; however, most systems today do not have the full integrative capacity of an EHR and therefore the term EMR will be used throughout this thesis.
health care providers, managers and policymakers to share information and use the best available evidence to guide their decisions. They can also forge a strong link between quality on the one hand and accountability on the other” (Romanow, 2001, p.77). More recently, Canada’s Health Minister Leona Aglukkaq stated that “an electronic health record system will improve the safety and accountability of the overall healthcare system…It will save time and lives by reducing duplication, improving the management of chronic disease, improving access to care and boosting productivity” (“Government of Canada”, 2009). Appointed by U.S. President Barack Obama, former National Coordinator for Health Information Technology Dr. David Blumenthal proclaimed that “the widespread use of electronic health records (EHRs) in the United States is inevitable. EHRs will improve caregivers’ decisions and patients’ outcomes…Hundreds of thousands of physicians have already seen the benefits in their clinical practice” (Blumenthal, 2010, p.501). Although there is a difference between EMR and EHR, adoption of local systems such as EMRs could form the backbone for an EHR, which adds an element of interoperability and information sharing.

Despite widespread consensus that EMRs are an important asset to the Canadian health care system, Canada has been slow to adopt and use EMRs to their full potential compared to other developed countries (Schoen, Osborn, Doty, Squires, Peugh, et al., 2009; Terry, Thorpe, Giles, Brown & Harris, 2008). For example, a 2009 Commonwealth Fund study reported 37% EMR adoption rate among Canadian general practitioners, and 65% of adopters reported low functional use. Both adoption and functional use were higher in most other developed countries. For example: the Netherlands was reported to have 99% adoption and 99% medium or high functional use (Schoen et al., 2009). These figures, along with the EMR adoption rates and utilization of other developed countries are shown in Table 1 below.
Concerning North America’s poor performance around EMR implementation, a literature review by Gagnon, Desmartis, Labrecque, Légaré, Lamonthe, et al. (2010) indicates “that about 75% of information system implementations in health care have failed” (p.10), while Kaplan and Harris-Salamone (2009) also affirm that the majority of HIS projects fail to meet intended goals and objectives. Studies examining the root of such failures cite human and organizational factors as some of the main barriers to EMR success\(^2\) (Archer & Cocosila, 2009; Gagnon et al., 2010; Kaplan & Harris-Salamone, 2009; Ludwick & Doucette, 2008; Schoen et al., 2009). For example, Ludwick and Doucette (2008) suggest that many of the unintended consequences associated with HIS implementation may increase with the level of “users’ dissatisfaction with

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\(^2\) For this thesis, EMR success is conceptualized based on the original DeLone and McLean Model of Information System Success. Further discussions on the conceptualization of EMR success are found throughout the following sections of this thesis.
the training and postsale experience with their vendor” (p.4). Archer and Cocosila (2009) also contend that the “service philosophy” of clinics, strong leadership, the repair of existing interpersonal and organizational issues, and “establishing psychological ownership from staff members” (p.126) are all measures that can be taken to overcome barriers to HIS success. As a final example, the previously cited Commonwealth Fund study highlighted the pivotal role of technical support in countries with high adoption rates and functional use of primary care EMRs (Schoen et al., 2009, p.1181).

According to the National Physician Survey, between 2007 and 2010, EMR adoption rates increased from 31.7% to 49% among Canadian general practitioners (College of Family Physicians of Canada, Canadian Medical Association, Royal College of Physicians and Surgeons of Canada, 2011). Thus, there is an increasing number of users who require post adoption end-user support—which we broadly define as: “any information or activity that is intended to help users better utilize, and solve problems with a system” (Shachak, Barnsley, Tu, Jadad, & Lemieux-Charles, 2012)—for these transitions to be successful. Although end-user support has been widely examined in information systems (IS) research (and recognized as an important determinant of IS success), it remains an understudied subject in health informatics research.

To provide a better understanding of support for EMR systems, a multiple case study examining the various ways in which end-user support affects the quality, use and impact of a proprietary EMR in 4 Ontario Family Health Teams (FHT) — what will be referred to as Case Study A—was replicated for this thesis. The supervisor of this thesis was the primary investigator for Case Study A, which was funded by the Canadian Institutes of Health Research. As a research assistant for Case Study A, the author of this thesis participated in the development of the study’s coding scheme (described below), coding data, and analyzing data for central themes. Methodological details of Case Study A (Dow, Montgomery, Barnsley, Tu, Jadad, Lemieux, & Shachak, 2012) include:

- Four Family Health Teams (FHTs) using the same proprietary EMR system were recruited for the study;
- Qualitative research using-semi structured interviews;
- Interviews were conducted on-site, in person, and took between 30 to 60 minutes to complete;
- Interviews were audio recorded and transcribed verbatim by a professional transcriptionist.

Unlike Case Study A, this thesis focused on support for an open-source EMR in an Ontario Family Health Organization (FHO), which provided a critical case for comparison with the original study.

This thesis proposes preliminary theoretical models that cut across organizational settings and EMR software to explain the various ways in which end-user support sources, characteristics, and activities affect EMR success. The implications of this research for health care managers and policy makers, including practical strategies for improving system and information quality and considerations for EMR certification/funding requirements, are discussed.
2 Literature Review

2.1 End-user support sources, characteristics and activities

Information systems (IS) researchers have long recognized the relationships between service quality (e.g., the degree to which services are aligned with support factors that users deem as important) and user satisfaction, which many regard as a reasonable measure of IS success (Bailey & Pearson, 1993; Bowman, Grupe, Lund, & Moore, 1993; Branchreau & Wetherbe, 1988, Buyukkurt & Vass, 1993; Delone & McLean, 1992; Gallager, 1974; Ives, Olson, & Baroudi, 1983; Lederer & Spencer, 1988; Ranier & Carr, 1992; Rivard & Huff, 1988; Shaw, DeLone, & Neiderman, 2002 and; Trauth & Cole, 1992). Despite this widespread agreement among IS researchers, there is a lack of research examining the specific ways in which various support-related factors affect users’ satisfaction (Nilsen & Sein, 2004; Shaw et al., 2002). According to Nilsen and Sein (2004), “simply put, neither the academic nor practitioner community has determined what the best [way] is to support the everyday user” (p.48).

Mirani and King (1994) argue that “it is imperative for IS researchers to study the causes of variations among the support needs of end-users so that these needs can be better understood, predicted, and fulfilled” (p.482). To provide a holistic view of this topic is inherently challenging. In addition to differences in organizational and system characteristics, computer proficiency is not uniform and users may require training, education and support services that are tailored to their individual needs (Mirani & King, 1994). The following are examples of research that provide us with useful conceptual tools for investigating this complex topic.

In their literature review, Nilsen and Sein (2004) identify several support factors with direct implications for user satisfaction. For example: 1) need: the link between users’ needs and their satisfaction is well known, specifically, users whose needs are fulfilled tend to be more satisfied; 2) awareness: the authors posit that there is a positive relationship between users’ awareness of support policies and satisfaction; in other words, the more aware users are of support policies, the greater their satisfaction; 3) user expectations: there is a well-established link between users’ expectations of support and satisfaction; and so the authors expect there to be a negative
relationship between support expectations and satisfaction. A less concrete variable (which has implications for user expectations) is 4) importance of computers at work. This variable is contentious since the importance users assign to IT can increase their need and expectations of support (which has negative implications for satisfaction); on the other hand, the more importance assigned to IT, the more likely users will have developed proficiency, thus reducing their needs for support (which has positive implications for satisfaction). Their study of user preferences for support in a Norwegian institution of higher education found that awareness of support policies was a significant factor influencing user satisfaction. Their findings also confirm the negative relationship between users’ needs/expectations of support and satisfaction, and the positive relationship between the perceived importance of IT and satisfaction with end-user support. The authors concluded that the technical knowledge and empathy of support personnel are not as important to users as having well-organized and transparent support policies.

Shaw’s et al. (2002) empirical study of 484 users in a large American university sought to uncover potential links between 21 end-user support factors and user satisfaction across different user-groups. They note that any correlations between end-user support factors and user satisfaction “may be contextual in that both the importance and performance for particular factors (and therefore the ‘gap’ between them) will vary among organizations” [sic] (p.42). Their findings highlight issues related to software upgrades (e.g., the learning curve associated with system upgrades) and the response time of formal support staff (which could have consequences for users’ productivity and schedules) as having a significant impact on user satisfaction across user-groups. In their words, “many of the proposed variables have shown mixed results, but software upgrades and IS staff response time have been significant factors in more than one study and therefore warrant further investigation” (p.51). The study’s mixed results may have resulted from additional contextual factors, which are important to consider when investigating the impact of support on IS success (Shaw et al., 2002).

Govindarajulu, Reithel, & Sethi (2000) examined the “factors that affect users’ attitudes toward alternative sources of support and the effect of these attitudes on user behavior” (p.78). The authors consider support from several sources, including information centers (IC), local management information system (MIS) and friend/colleagues, which span the range of formal, semi-formal and informal support.
In their review of the literature on end-user support, Govindarajulu et al. (2000) identify the following factors as influencing users’ attitudes towards various support sources:

1) **The degree to which support services are aligned with user needs:** They cite a study by Rainer and Carr (1992) in which there was a significant mismatch between the support services offered by ICs and those actually needed by users;

2) **The proximity of services:** The authors conjecture that there is a positive relationship between user satisfaction and the proximity of support (e.g., onsite or local support);

3) **The quality of support personnel:** For example, researchers have identified knowledgeable staff and excellent communication with end-users as vital to IC success. Similarly, Munkvold (2003) highlights characteristics of support personnel such as counseling skills (e.g., empathy towards users’ level of IT self-efficacy) as being vital to effective support;

4) **The quality of end-user computing applications (e.g., the accuracy, reliability, and completeness of applications):** Their survey of 1000 mid-level managers (155 responded to the survey) and their preferences for end-user support revealed they were more satisfied with formal IC support than informal support from friends and colleagues. In addition, the characteristics of support personnel, the quality of applications, the degree to which support services were aligned with user needs, and the proximity of support services all had “a significant effect on user attitude,” with proximity of support as “the construct most closely related to user attitude” (p.84).

Munkvold (2003) also considers personal/informal consultation with colleagues, personal/formal consultation with computer experts and the use of external and internal documentation (which was not discussed by the above researchers) as sources of end-user support. Similarly, Torkzadeh and Doll (1993) contend that “initial training of full-time users is usually necessary; however, they also have a continuing need for support…Quality user documentation can provide continuing and often cost-effective point-of-need support for both full time and intermittent users” (p.157). The effectiveness of these manuals largely depends on their user-centeredness (Carroll, Smith-Kerker, Ford, & Mazur-Rimet, 1988). Today, there is a well-established body of research detailing theories and methods for designing intuitive, user-centered instruction
manuals; for example Minimalism, which is one of the most influential approaches to the design of tutorials and user manuals (van der Meij, Karreman, & Steehouder, 2009), which is discussed in the following section.

### 2.2 The Principles of Minimalist Documentation

In their research, Carroll et al. (1988) made several observations about users’ learning behaviors. For example, they were “repeatedly struck” by users’ tendency to carry out real tasks irrespectively of the “step-by-step guidance of their [conventional] training materials” (Carroll et al., 1988, p. 75). Thus, to engage learners, they stress the need for user manuals to “focus on real tasks and activities” (p.74). Given the propensity for users to learn through action rather than by reading, wordy instructions resulted in a number of unintended consequences such as skipping or misreading crucial steps and users being deterred by the manual’s size. Where a non-Minimalist manual would try to minimize reading problems by adding “control information” (e.g., sections on how to use the manual itself), thereby increasing its size, proponents of Minimalist documentation would recommend the inverse—that is to “slash the verbiage” as much as possible (Carroll et al., 1988, p. 76). Furthermore, since users are eager to carry out real tasks—to learn through exploration essentially—they are bound to a) take actions that require verification and b) make mistakes that require correction (learning habits that standard training manuals fail to address) (Carroll et al., 1988). Given these tendencies, and since users are fallible in general, Carroll et al. (1988) propose the Minimalist design principle of supporting error recognition and recovery. In sum, Carroll et al. (1988) identify the following tenets of a minimal manual:

1) Focus instructions on real tasks and activities;
2) Minimizing verbiage;
3) Support error recognition and recovery.

In a later work, van der Meij and Carroll (1998) tried to define the principles of Minimalism in greater detail. Building on previous theoretical and empirical research into the relationships between Minimalism and learning performance, they propose 4 principles for designing Minimalist instruction, each with its own set of heuristics. These principles and heuristics are described in Table 2:
Table 2

*Principles and heuristics for designing Minimalist instruction (from: van der Meij & Carroll, 1998)*

<table>
<thead>
<tr>
<th>Principle</th>
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<tr>
<td><strong>Principle 1: Choose an action-oriented approach</strong></td>
<td></td>
</tr>
<tr>
<td>Heuristic 1.1:</td>
<td>Provide an immediate opportunity to act.</td>
</tr>
<tr>
<td>Heuristic 1.2:</td>
<td>Encourage and support exploration and innovation.</td>
</tr>
<tr>
<td>Heuristic 1.3:</td>
<td>Respect the integrity of the user’s activity.</td>
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<tr>
<td><strong>Principle 2: Anchor the tool in the task domain</strong></td>
<td></td>
</tr>
<tr>
<td>Heuristic 2.1:</td>
<td>Select or design instructional activities that are real tasks.</td>
</tr>
<tr>
<td>Heuristic 2.2:</td>
<td>The components of the instruction should reflect the task structure.</td>
</tr>
<tr>
<td><strong>Principle 3: Support error recognition and recovery</strong></td>
<td></td>
</tr>
<tr>
<td>Heuristic 3.1:</td>
<td>Prevent mistakes whenever possible</td>
</tr>
<tr>
<td>Heuristic 3.2:</td>
<td>Provide error information when actions are error prone or when correction is difficult.</td>
</tr>
<tr>
<td>Heuristic 3.3:</td>
<td>Provide error information that supports detection, diagnosis, and recovery.</td>
</tr>
<tr>
<td>Heuristic 3.4:</td>
<td>Provide on-the-spot error information.</td>
</tr>
<tr>
<td><strong>Principle 4: Support reading to do, study and locate</strong></td>
<td></td>
</tr>
<tr>
<td>Heuristic 4.1:</td>
<td>Be brief; don’t spell out everything.</td>
</tr>
<tr>
<td>Heuristic 4.2:</td>
<td>Provide close for chapters.</td>
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</tbody>
</table>
Carroll et al. (1988) applied these principles to the design of a Minimalist manual for a popular word processing system, which was then used to evaluate users’ learning performance against a commercially developed or “standard” manual. Their study revealed significant differences between the two groups. For example, the Minimalist manual (MM) user group learned the system considerably faster and completed more tasks than the standard manual (SM) user group (Carroll et al., 1988). Van der Meij and Lazonder’s (1993) empirical study, which was based on the work of Carroll and his colleagues and included additional methodological controls, produced similar findings. In their study, participants using a MM completed tasks faster, experienced fewer errors and—when encountered—required shorter recovery time than the control group. Similar findings can be found in Black, Carroll, and McGuigan (1987), Gong and Elkerton (1990), Ramsay and Oatley (1992) and Wendel and Frese (1987). Conversely, studies by Davis and Bostrom (1993) and Davis and Wiedenbeck (1998) did not reveal any significant performance gaps between learners using Minimalist and other instructional methods. Nonetheless, following its popularization during the 1980s and 1990s, many technical writers have since embraced the tenets of Minimalism (van der Meij et al., 2009). In other words, Minimalism is now a widely accepted approach which affects current practices of software documentation.

2.3 End-user Support for Health Information Systems

Thus far, end-user support for IS in general has been outlined; however, as mentioned in the introduction, it is a budding and important topic in HIS research as well. The purpose of the following section is to provide an overview of HIS research dealing with end-user support in the clinical domain.

While many studies have demonstrated the benefits of HIS adoption, others have described unintended consequences such as disruptions to clinical workflow, increased medical errors, and user frustration (Ludwick & Doucette, 2008; Patel & Kaufman, 2002; Shachak et al., 2009). Ludwick and Doucette (2008) speculate whether such unintended consequences are a result of “users’ dissatisfaction with the training and postsale experience with their [EMR] vendor” (p.4). Likewise, Petersen (2010), Terry et al. (2008) and Lai, Lau, & Shaw (2009) contend that HIS success depends on ongoing and effective end-user support.
Petersen endorses Das’ (2003) definition of technical support as “a post-sales service provided to customers [or users in organization] of technology products to help incorporate a given product into their work environment” [sic] (p.899). Although in Petersen’s view back-end support in health care settings is an important factor influencing HIS success, it remains an understudied topic. Since face-to-face verbal communication and information technology are essential in modern healthcare settings, Petersen (2010) considers on-site support to be a complementary and necessary service. In line with Petersen (2010), a qualitative study of EMR users in Ontario primary clinics conducted by Terry et al. (2008) revealed the importance of rapid and on-site support that is compatible with HIS users’ workflow in relation to EMR implementation success. Furthermore, findings from Lai’s et al. (2009) survey, which examined physicians’ experiences during the implementation of EMR systems in British Columbia, underscore the need for: a) clinical leadership during the implementation process; b) strong pre-implementation support (e.g., assessing the impact of EMRs on clinical workflow prior to implementation); and c) selecting an EMR vendor that is committed to providing ongoing support services.

Fernando’s (2010) Australian case study examined views of information security of formal IT support personnel and clinical staff working in a hospital setting. The study found a mismatch of perceptions between the two groups around issues of eHealth privacy and security. This resulted in unreliable data being entered into patients’ records, which was purported to have a negative impact on the quality and safety of patient care (Fernando, 2010). In a similar vein, as part of a systematic review, Adaji, Schattner & Jones (2008) cite a lack of training around HIS as a barrier to providing quality care to diabetes patients. These two final examples suggest that better understanding of end-user support for EMRs is not only necessary to help ease the implementation of these systems, but it may also serve to improve the quality and safety of patient care as well.

2.4 Models for Evaluating HIS Success

HIS researchers have begun to incorporate end-user support related factors into models for evaluating HIS success. This trend, its theoretical origins, criticisms, and relevance to this study are discussed below.
A popular theory for evaluating IS success is the DeLone and McLean (D & M) Model of IS Success. Based on communication theory, the model’s interrelated constructs are:

- System and information quality;
- Use and user satisfaction and;
- Individual and organizational impacts (as shown in Figure 1).

DeLone and McLean (1992) describe the model as one that “recognizes success as a process construct which must include both temporal and causal influences in determining IS success” (p.83). Critics of the D & M Model of IS Success cite its omission of certain key constructs and its superfluous attention on immediate users for measuring the impact of IS (Pitt, Watson, & Kavan, 1995; Seddon, 1997). Consequently, DeLone & McLean (2003) revised the model by:

a) Adding “service quality” as an independent variable of IS success;

b) Adding “intention to use” as an adjunct to “use” and;

c) Integrating the dependent variables of individual and organizational impact into “net benefits” (as shown in Figure 2).

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**Figure 1.** Original D&M Model of IS Success (From: DeLone & McLean, 2003)
Perhaps owing to its comprehensiveness, extensive validation, specific categories of evaluation and applicability to HIS (Yusof, Kuljis, Papazafeiropoulou, & Stergioulas, 2008), the D & M Model of IS Success is becoming an increasingly popular tool among health informatics researchers. The following extensions of the D & M Model of IS Success were developed to evaluate HIS success.

As previously mentioned, the potential benefits of adopting HIS include: enhanced clinical productivity, better coordination of care, improved health outcomes and patient safety, reduced costs and better access to care (Byrne et al., 2010; Car et al., 2008; Chaudry et al., 2006; Hillestad et al., 2005; Lau et al., 2011). To demonstrate these benefits, jurisdictions are increasingly making use of benefits evaluations (BE). The purpose of BE “is to determine whether the HIS adoption effort by clinicians is successful and if benefits are being realized” (Lau et al., 2011, p.40). A notable example is the Benefits Evaluation (BE) Framework developed by Canada Health Infoway. Published in 2007, the BE Framework is one among a growing number of HIS specific extensions of the D & M Model of IS Success that provide a theoretical basis for “understanding the quality, use and net benefits of HIS adoption within healthcare organizations” (Lau et al., 2011, p.40). Key elements of the BE Framework include:

- Information quality includes such criteria as completeness, ease of understanding and relevance;
- System quality includes adaptability, availability and response time;
Service quality includes assurance and responsiveness;

- The quality of the information, system and service can affect the extent of system use, intention to use, and user satisfaction;

- In turn, system usage and satisfaction can lead to positive and negative impacts at the individual and organizational levels, which are collectively viewed as net benefits (Canada Health Infoway, 2006, p.8).

Lau et al., (2011) include a series of approaches for evaluating HIS implementation (including Infoway’s BE framework) within their Clinical Adoption (CA) Framework. For example, the System and Use Assessment (S and U), also developed by Canada Health Infoway, is a survey tool consisting of 24 questions designed to “assess the quality, usage and net benefits of an HIS in an organization” (p.43). While some of the survey’s questions can be tailored to specific health care settings, a certain number of “core” questions are included for reasons of comparability. The System and Use Assessment falls under the “micro” dimension of the CA Framework, which includes the quality of HIS (e.g., the “responsiveness of support services,” and the availability, accuracy, and completeness of clinical information), usage quality (e.g., user satisfaction), and net benefits (e.g., better coordination of care, efficiency, and better quality patient care). Thus, the micro dimension of the CA Framework is largely based on the D&M Model of IS Success. Here it is worth highlighting the connection made by Lau et al., (2011) between the responsiveness of support services and the quality of HIS, which is a recurring theme in the literature which this thesis explores (empirically) within the context of primary care EMRs.

Another framework (also based on the D&M Model of IS Success) for evaluating HIS success is the “human, organization and technology-fit (HOT-fit)” developed by Yusof et al. (2008). Frameworks for evaluating HIS success have typically focused on clinical processes and technical issues; however, such frameworks fall short of explaining, holistically, why systems fail or succeed in specific settings. To address these explanatory shortcomings, Yusof et al. (2008) developed a theoretical extension of the D&M Model of IS Success that takes into account organizational, human and technological factors in tandem. They argue that this more holistic approach is needed because “the more technology, human, and organization fit with each
other, the greater the potential of HIS” (p.386). The following sections describe the relevance and interrelatedness of each of these factors.

Organizational factors used to evaluate HIS success (which are an extension of the D&M Model of IS Success) are 1) its environment, which includes funding sources and inter-organizational relationships and 2) the structure of the organization, which includes the type, size, culture and leadership of the organization (Yusof et al., 2008). Here it is worth underlining the relevance of structure (of health care organizations) as a category for evaluating HIS success. Gagnon’s et al. (2010) case study of a Family Medicine Group (FMG) in rural Quebec identified several organizational factors as contributing to the successful implementation of an EMR system. For instance, in addition to the constructive role of vendor-provided technical support, the study highlighted the important role of project leaders or “champions”. An associate of the FMG with extensive experience in both health informatics and clinical work was an ideal knowledge broker, one who was able to communicate effectively and share knowledge between vendors and clinicians. Ash, Stavri, Dykstra, and Fournier (2003) also highlight the importance of champions (e.g., health care managers) and “bridgers” (e.g., clinicians) who are familiar with and are able to communicate both the cultural and technical aspects of clinical systems. More in line with the revised D&M Model of IS Success is Yusof’s et al. (2008) inclusion of technical factors (e.g., the dimensions of system, information and service quality), which are described in greater detail below.

Within the D&M Model and related frameworks, measures of system quality include the ease of use, learnability, reliability, accessibility, flexibility and response time of HIS (Yusof et al., 2008). Other researchers (both IS and HIS) have cited the usability, time savings, availability and response time of systems as the main attributes of system quality (Hier, Rothschild, Lemaistre, & Keeler, 2005; Meijden, Tange, Troost, & Hasman, 2003; Staggers, Jennings, Lasome, 2010; Zhang, Walji, Patel, Gimbel, & Zhang, 2009). These researchers have also described the links between these attributes and IS/HIS success.

Measures of information quality include the accuracy, completeness, legibility, timeliness, relevance and consistency of information (Hayrinen’s et al., 2007; Meijden’s et al., 2003; Yusof et al., 2008). Thiru’s et al., (2003) systematic review concluded that there is a lack of tools for objectively measuring the quality of EMR information (thus making it an untenable category of
EMR success). More recent reviews, however, have applied standards for measuring information quality and conjectured that EMR usage enhances the accuracy and completeness of medical information (Hayrinen et al., 2007).

Measures and attributes of service quality are widely discussed in the IS and HIS literature. For example, Yusof et al. (2008) included the timeliness, assurance, follow-up, and empathy of technical support within their HOT-fit framework (Yusof et al., 2008). Haggerty and Compeau (2002) similarly underscore the quality of verbal modelling, problem solving capabilities and service quality as the key attributes of support. These attributes were purported to have a positive influence on users’ IT competency and their ability to solve problems with the system (Haggerty & Compeau, 2002). As previously cited, Munkvold (2003) also underlines characteristics of support personnel such as counseling skills (e.g., empathy towards users’ level of IT competency) as key measures of effective support.

Human factors, which are also in line with the D&M Model of IS Success, include the interrelated dimensions of system use and user satisfaction (topics explored in previous sections). System use, according to Yusof et al. (2008), refers to users’ voluntary use, acceptance, resistance, beliefs and expectations of HIS. Other IS researchers have favoured more positivistic measure of system use (e.g., frequency of use, duration of user and number of entries) (Meijden et al., 2003); however, this thesis is more concerned with the subjective experiences of HIS users and the ways they affect user satisfaction (discussed earlier as widely used measure of IS/HIS success). While HIS researchers like Hier et al. (2005), Sittig, Kuperman, and Fiskio (1999) and Laerum (2001) report high satisfaction among HIS users, others have reported moderate to low satisfaction and mixed perceptions among EMR users (Lee, Teich, Spurr, & Bates, 1996; Whitten, Buis, & Mackert, 2007).

Finally, “net benefits”, which is borrowed from the updated D&M Model of IS Success, denotes the balance between negative and positive impacts of HIS on individuals and organizations (Yusof et al., 2008). Individual impacts include the impact of HIS on users’ workload, work routines and the overall quality of their performance (e.g., effectiveness, efficiency, decision quality, and error reduction) (Yusof et al., 2008). While EMRs can help to streamline clinical work routines, impacts such as increased workload, workflow disruptions, and information overload have been reported (Meijden et al., 2003; Keshavjee, Troyan, Holbrok, &
VanderMolen, 2001; Lehoux, Sicotte, & Denis, 1999; Sicotte, Denis, Lehoux, & Champagne, 1998). Organizational level impacts include reduced costs, improved efficiency, higher quality patient care, enhanced communication and better access to information (Yusof et al., 2008).

In their case study of a primary care clinic affiliated with two specialized hospitals, Yusof et al. (2008) discovered several links between HOT-fit factors and EMR implementation. For example, factors with negative implications for HIS implementation were: system response time, system usefulness, user perceptions and skills, and the empathy of support personnel. Factors with positive implications for HIS implementation were: leadership, information relevancy, user attitudes, organizational readiness, inter-organizational communication and clinical processes.

For the purpose of this study, the original D&M Model of IS Success was adopted since:

a. We sought to examine service quality as an independent variable of EMR success, which is conceptualized as a dependent variable in the revised model;

b. We sought to examine the impact of end-user support on specific attributes related to the dependent variables of “individual” and “organizational impact”, which are replaced by the generic category of “net benefits” in the revised model;

c. We sought to extend the construct of “organizational impact” to account for the EMR’s impact on patient care.

Accordingly, data for this thesis were collected and organized using the interview protocol found in Appendix A and the coding scheme found in Appendix B, which were both used in Case Study A and are based in part on the original DeLone and McLean Model of IS Success. A schematic of this modified framework can be found in Figure 3 (p. 26).

2.5 Models of primary care: Family Health Teams and Family Health Organizations

In 2004, the government of Ontario vowed to repair the province’s underperforming health care system, which began to wane during the mid-1980s (Rosser, Colwill, Kasperski, & Wilson, 2011). Leading members of the health care community attributed this decline to the fee-for-service model, which provided “perverse incentives which rewarded high-volume practices at the expense of person-centered care” (p.166). The dramatic increase in workload to result from this payment structure encouraged family physicians to curtail services and to increase referrals to
specialists. Consequently, medical students increasingly moved towards specialized areas of medicine, which led to a shortage of family physicians (Rosser et al., 2011). According to Rosser et al. (2011), this “posed a real threat for Canada’s health care system” (p.166).

In response to this “threat”, the Government of Ontario launched a series of initiatives, including: the Family Health Group (FHG), Community Health Center (CHC), Family Health Networks (FHN), Family Health Team (FHT) and Family Health Organization (FHO) models of primary care (Government of Ontario, 2009; Rosser et al., 2011). The FHT (est.2004) and FHO (est.in 2006) are the latest models of primary care to be implemented by the Government of Ontario (Government of Ontario, 2009; Rosser et al., 2011). FHTs and FHOS are similar in that they both serve a general population and are remunerated based on a “blended funding formula” made up of capitation and added financial incentives (e.g., for realizing preventive care targets and fee-for-service) (Government of Ontario, 2009; Rosser et al., 2011). However, unlike FHOS, FHTs offer patients interdisciplinary health care services (i.e., care that is coordinated between physicians, mental health professionals, social workers, dieticians, physiotherapists and other health professionals.) Both models are entitled to funding through the Ontario Physician IT Program and typically use EMRs for the following purposes:

- Providing an infrastructure for assessing clinical performance;
- Managing clinical targets;
- Billing clinical services and generating revenue;
- Facilitating communication among clinical staff.

There are currently 12 certified primary care EMR systems in Ontario. Most of them are proprietary systems provided by EMR software vendors. One system (OSCAR, developed at McMaster University) is open-source. Below is a brief review of open-source in Medical Informatics.

3 The physician IT Program is a comprehensive program that assists physicians in the acquisition, implementation and adoption of information technology. OntarioMD, a wholly owned subsidiary of the Ontario Medical Association, administers the program (Shachak et al., unpublished).
2.6 Open-source in Medical Informatics

Barriers to EMR adoption in primary care include vendors’ transience, high costs, and a lack of standardization around medical data (Bates, Ebell, Gotlieb, Zapp, & Mullins, 2003). Kantor, Wislon, & Midgley (2003) posit that open-source software (OSS) in Medical Informatics is a practical way to mitigate these and other adoption barriers. Nevertheless, OSS may present adopters with different and unforeseen challenges. In order to provide a balanced view of OSS, the following section describes its main attributes, its relevance to Medical Informatics, as well as its advantages and drawbacks.

The term ‘open-source’ has been used for the past 20-40 years to describe a specific “approach to licensing and distributing software” (Mcdonald, Schadow, Barnes, Dexter, Overhage, et al., 2003, p.175). Characteristics of OSS include open access to the source code, and often waived licensing fees and nominal licensing restrictions (Mcdonald et al., 2003). While this model may seem nonsensical from a traditional business point of view (e.g., proprietary vendors use licensing fees to generate revenue, develop and maintain their software, and restricted access to the source code ensures a more reliable product), Mcdonald et al. (2003) contend that OSS is a viable and favorable alternative to the commercial model of software development. Their main argument for open-source is “that when everyone can see the source code the software gets more scrutiny and more corrective feedback than a single development team can provide; so it leads to better software” (p.178). Other advantages of OSS include: 1) minimizing the risks associated with vendors’ transience and poor support for certain (usually older) versions of products. In the case of OSS, users, user groups, and private firms can provide (and compete to provide) support for various versions of a software package, thereby prolonging its lifespan; 2) Incorporating OSS modules into commercial software allows vendors to cut down on research and development costs, thus enabling them to shift resources towards technical support and products’ commercial components; 3) OSS encourages the development of a more standardized and interoperable product (a relevant example is Web browsers); 4) OSS provides ample opportunities for academics and other groups to partake in the design process (Mcdonald et al., 2003), and lastly; 5) OSS facilitates data migration between systems, which is particularly beneficial in the case of transient vendors or when clients switch systems (A. Shachak, personal communication, March 1, 2012).
Open-source is not, however, synonymous with public domain (i.e., no licensing or copyright limitations). Although licenses and copyright agreements are needed in order to maintain the “openness” of OSS (Mcdonald et al., 2003), advocates of open-source are not opposed to the for-profit sale and technical support of OSS. In fact, many commercial firms have been created to improve, distribute and support a number of open-source products (Mcdonald et al., 2003).

OSS licenses range from the more restrictive (e.g., new software that are based on the source code of OSS must also remain open-source) to the more lenient (e.g., proprietary software developers are permitted to incorporate code that is open-source into commercial products so long as they cite their sources). Janamachi, Katsamakas, Raghupathi, & Gao (2009) contend that the choice of licensing agreement for open-source applications in Medical Informatics has a significant impact on developers’ (or potential developers) willingness to partake in projects, the quality of the project, and “the incentives of users to adopt a software application” (p.458).

Advocates of OSS in Medical Informatics are concerned that a market dominated by proprietary vendors limits the space for which individuals and groups such as academics can contribute to the advancement of HIS. Mcdonald et al. (2003) envisage that “the very process of allowing Medical Informatics researchers to implant novel modules on existing health care systems could unleash creativity and accelerate progress” (p.179). Widely available standards such as Health Level Seven International (HL7) messaging (which make it possible to link open-source applications to proprietary systems), database standards such as Structured Query Language, internet standards such as Extensible Markup Language (XML), and vocabulary systems such as Systematized Nomenclature of Medicine (SNOMED) can together provide an infrastructure that would enable open-source applications to share information with proprietary systems (Mcdonald et al., 2003). In other words, embracing open-source in Medical Informatics is seen as a realistic way to adapt systems to local requirements and improve the quality of HIS (Mcdonald et al., 2003).

Lastly and perhaps most relevantly, since OSS development costs are lowered, developers and distributors can shift resources towards end-user training and support, customizing software to specific user settings, and the implementation of systems (which all add value to the system and increase the likelihood of HIS success) (Kantor et al., 2003). Kantor et al. (2003) predict that “open-source EMR vendors can become professional service providers (the economic model of
medicine itself), competing on service quality rather than on the basis of software secrets” (p.616). A related advantage of OSS is that it frees users from ‘vendor lock-in’—that is, they are free to solicit support services from alternative (and in some cases competing) sources. This can be of benefit in the case of transient vendors/service providers or ones that provide inadequate support (Kantor et al., 2003).

Despite these benefits, several criticisms can be leveled against OSS. According to Raghunathan, Prasad, Mishra, and Chang (2005), “one of the frequent criticisms of open-source software is that they are of lower quality compared to their closed source counterparts” (p.903). This, according to OSS critics, is a result of a) the so-called “free rider effect”, where the majority of users rely on others to develop a product and b) OSS products lacking formal project management (Prasad et al. 2005). The following table, adopted from Aberdour (2007), demonstrates some of the quality management differences between proprietary and OSS.

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Proprietary</th>
<th>Open-source</th>
</tr>
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<tbody>
<tr>
<td> Well-defined development methodology</td>
<td> Development methodology often not defined or documented</td>
<td></td>
</tr>
<tr>
<td> Extensive project documentation</td>
<td> Little project documentation</td>
<td></td>
</tr>
<tr>
<td> Formal, structured testing and quality assurance methodology</td>
<td> Unstructured and informal testing and quality assurance methodology</td>
<td></td>
</tr>
<tr>
<td> Analysts define requirements</td>
<td> Programmers define requirements</td>
<td></td>
</tr>
<tr>
<td> Formal risk assessment process—monitored and managed throughout project</td>
<td> No formal risk assessment process</td>
<td></td>
</tr>
<tr>
<td> Measurable goals used throughout project</td>
<td> Few measurable goals</td>
<td></td>
</tr>
<tr>
<td>Defect discovery from black-box testing as early as possible</td>
<td>Defect discovery from black-box testing late in the process</td>
<td></td>
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<tr>
<td>-------------------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Empirical evidence regarding quality used routinely to aid decision making</td>
<td>Empirical evidence regarding quality isn’t collected</td>
<td></td>
</tr>
<tr>
<td>Team members are assigned work</td>
<td>Team members choose work</td>
<td></td>
</tr>
<tr>
<td>Formal design phase is carried out and signed off before programming starts</td>
<td>Projects often go straight to programming</td>
<td></td>
</tr>
<tr>
<td>Much effort put into project planning and scheduling</td>
<td>Little project planning or scheduling</td>
<td></td>
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From this table, it is clear that proprietary software has several advantages over OSS in terms of quality assurance. Furthermore, many of the benefits of OSS described above are based on opinions and anecdotal evidence. Some of the empirical research into OSS provides us with a more balanced perspective of the matter. For example, Morgan and Finnegan’s (2007) field study of 13 IS managers identified several drawbacks of OSS; the two most relevant to this study were: 1) Lack of support and accountability: most of the study’s participants felt that, without the backing of a commercial firm, the quality of support services diminished, in part because there is no entity to hold responsible or accountable for problems with OSS products and; 2) it is difficult to train and recruit staff with the competencies needed to work with an OSS system (Morgan & Finnegan, 2007).
2.7 Summary of Literature Review

Based on this literature review, it is clear that end-user support is a contextual, complex and important factor influencing IS success. Key points to consider when examining this subject include:

- The proximity of support
- The source of support
- Support characteristics
- Support activities
- Organizational characteristics
- IS characteristics
- Users characteristics
- Vendor characteristics

Although researchers have begun to explore these factors in relation to HIS success, there remains a dearth of research on the subject (particularly for primary care EMRs).

Health informatics researchers are beginning to apply models for evaluating IS success to HIS. While such researchers (reviewed for this thesis) recognize the relationships between end-user support and HIS success, most offer only limited analyses of the matter. This critical case study attempts to provide a more comprehensive view of this topic by replicating a multiple case study that investigated the various ways in which end-user support affects the quality, use and impact of commercial EMR system in 4 Ontario FHTs. As mentioned, findings from this study can contribute to our theoretical understanding of end-user support, provide policy makers with needed requirements for EMR certification/funding, and provide health care managers with practical strategies for improving system and information quality.
3 Research Questions

The main purpose of this study is to investigate the ways in which post adoption end-user support affects EMR success. As discussed above, we define end-user support as “any information or activity that is intended to help users better utilize, and solve problems with a system” (Shachak, et al., 2012). The main facets of end-user support examined for this study were its sources, characteristics and activities. Sources of end-user support included formal (i.e., any person or body whose job it is to provide support—sometimes within the organization itself) and informal (i.e., peer-provided) support. The proximity of these sources (i.e., on-site or off-site) and formal and informal sources of impersonal support (i.e., user documentation) were also included in this investigation. The characteristics of support explored for this study included the knowledge, counseling skills, service quality and business model of formal support providers. Support activities examined were data support, hardware support, functional support, training and education, and project management support (the various aspects of end-user support are described in further detail in Appendix B).

Following the original DeLone and McLean Model of Information System Success (found in Figure 1), we used the interrelated constructs of information and system quality, individual impact and user satisfaction and organizational impact as the attributes of EMR success. In addition, we added patient care impact, which is an important success factor specific to HIS. A schematic of this modified framework can be found in Figure 3 below.
This investigation was divided into three research questions:

1) *In what ways does post adoption end-user support affect EMR success for an open-source system adopted in a semi-rural Family Health Organization?*  
The purpose of this segment was to gain an in-depth understanding of users’ perceptions of support and the ways it affects the success of an open-source EMR software in a particular setting. As discussed below, it also provides a critical case for the EMR system and settings included in Case Study A.

2) *What are the differences between formal and informal sources of impersonal support—both for the open-source software EMR investigated for the first part of this thesis and the proprietary EMR used in Case Study A?*  
This question was studied in an attempt to identify user needs which are not supported by current documentation, and new elements which may be included in user guides for EMRs.

3) *What are the commonalities and differences in the ways end-user support affects EMR success for the open-source EMR used in the clinic selected for this thesis and the proprietary EMR selected for Case Study A?*  
This question was studied in order to identify differences and similarities in support as it related to the following key areas:

a) Models of primary care (FHTs and FHOs);
b) Contextual factors (e.g., affiliation with hospitals) and;

c) Support for an OSS and proprietary EMR.

The methods employed to investigate these research questions are described below.
4 Methods

4.1 A Case Study of an OSS EMR in a semi-rural FHO

4.1.1 Study design

To answer the first research question, a case study approach was chosen since it enables the researcher to “retain the holistic and meaningful characteristics of real-life events” (Yin, 2003, p.2). Furthermore, since the purpose of this segment was to gain an in-depth understanding of users’ perceptions of support and its links to EMR success, qualitative research methods were employed as discussed below.

4.1.2 Case Selection

We sought to recruit a primary care organization that was eligible for funding under the Ontario Physician IT Program. It was also important to select a clinic that used an alternative system to the one investigated in Case Study A. Because of the differences between open-source and proprietary systems discussed earlier, we were particularly interested in an organization that uses OSCAR EMR software—the only certified open-source EMR in Ontario. With assistance from this thesis’ supervisor, two sites that fit these two criteria were contacted (one FHT and one FHO). Only one of them—the FHO—agreed to participate in the study. The FHO was co-located in a small town/semi-rural area, and had no formal affiliation with a hospital.

4.1.3 Participant Recruitment

First, since this thesis involved human subjects, ethics approval was obtained from the Research Ethics Board of the University of Toronto. Following ethics approval, a lead physician from the FHO was contacted and informally consented to the study. Next, the supervisor of this thesis and its principal author made a visit to the FHO to further explain the purpose of the study and why participation would be of benefit to the clinic. During the visit, consent forms were distributed to all of the FHO’s administrative staff and physicians who were the users of the EMR. It was important to include participants from both user groups since a) the support needs, expectations, and realities of each group may vary; b) a holistic view of EMR success must
include all users of the system; c) it provided a level of comparison that is consistent with Case Study A, which also involved various user groups (physicians, nurses, allied health professionals, and administrative staff) and by extension; d) supported the goal to propose preliminary theoretical models, that cut across organizational settings and EMR software, to explain the impact of end-user support on the measures of EMR success detailed in section 5.1.2 below. Three physicians and four administrative staff agreed to participate in the study (70% response rate) and were interviewed as described below.

4.1.4 Data Collection

According to Yin (2003), the interview is “one of the most important sources of case study information” (p.90). Semi-structured face-to-face interviews were the principal data collection method for this study. A benefit of this interviewing technique is that it allows the interviewer to better capture impromptu and important insights. For example, if a respondent raises a noteworthy point, the interviewer can ask him/her to elaborate on it, resulting in more comprehensive data for analysis. Conversely, if a particular line of inquiry is not producing fruitful responses, it can be modified on-the-spot, thus maintaining the relevance of the interview and usefulness of data collected (Knight, 2002).

All 7 interviews were approximately 30-45 minutes and took place at the FHO. To support comparison with Case Study A, participants were interviewed using the same semi-structured interview protocol [Appendix A] and were remunerated $100 for their participation in the study. In order to ensure consistent interviewing techniques, the research coordinator from Case Study A (who interviewed several participants from that study) was present during the first interview and provided feedback to the author afterwards. The following six interviews were conducted by the principal author of this thesis alone. Interviews were audio recorded, transcribed and then uploaded into Nvivo 9.

4.1.5 Data Analysis

Interview transcriptions were coded using the same coding scheme as in Case A (Appendix B), which was programmed into Nvivo 9. The trustworthiness of coding was ensured by way of researcher (or investigator) triangulation (Denzin, 1970): all interviews were coded by the primary investigator; 4 out of 7 were also coded by a second team member (either the supervisor
of this thesis or the research coordinator for Case A). Disagreements above 7% were reviewed together by all three team members and the coding was adjusted through a consensus-building process. The next step was to analyze coding summaries—generated through Nvivo 9—for main or recurring themes. Similar to the process of ensuring the trustworthiness of coding, all coding summaries were analyzed by the author of this study. Summaries for three coding sets were also analyzed by a second team member (either the supervisor of this thesis or the research coordinator for Case A). Following this, unique/noteworthy observations were integrated and major discrepancies adjusted accordingly.

4.2 Comparing User Documentation for an Open-Source and Proprietary EMR

To answer the second research question, impersonal resources pertaining to building e-forms i.e., automated “forms that can be used in the…EMR…to record patient/client specific information” (e.g., government forms and clinical resources) (OSCAR, 2012), were sampled for analysis. This component of the EMR was purposely chosen for its potential to streamline clinical work, promote interoperability, standardize clinical information, and its frequent mention by users during interviews in the case study as well as Case Study A.

4.2.1 Data Collection

As part of the interview protocol, users were asked: “what documents do you have that have been useful in helping you to plan for or use the system? Can you provide a copy to us?” Together with users’ responses, copies of informal (i.e., user-generated) and formal (i.e., vendor-provided) support documentation were collected. The sources of impersonal support included in this part of the study were:

- An unofficial document for the OSS EMR;
- The official OSS EMR user manual;
- The official user manual for the proprietary EMR from Case Study A;
- A user generated manual from one of the Case Study A sites;
- The OSS EMR’s online society of users (OSU) (page entitled “eForms”).
Sections of these sources pertaining to e-forms were analyzed as described below.

A unique aspect of OSS is the ability for users to partake in the development, refinement, and servicing of products. Online communities are a well-known source or “space” for users to share information about these activities. Although somewhat different from printed resources, it was therefore fitting to include the open-source EMR’s online society of users (OSU) as a source of impersonal support for this study. As with the previous sources of impersonal support, the OSU page pertaining to the development of e-forms (also known as custom forms) was selected for analysis.

4.2.2 Data analysis

The sources of impersonal support described above were analyzed according to the heuristics and principles of Minimalist documentation outlined by van der Meij and Carroll (1995), which have been described earlier. In particular, the analysis focused on the following four principles:

1) Taking an action-oriented approach (e.g., providing users with an opportunity to act and supporting learning by exploration);

2) Anchoring the tool in the task domain (e.g., presenting users with real-life/contextualized tasks);

3) Supporting error recognition and recovery (e.g., error information that is clearly indicated as such and is distinct from the surrounding information);

4) Supporting reading to do (e.g., a balance between declarative and procedural information) (van der Meij & Carroll, 1995).

Sections on building e-forms from selected resources were reviewed against these principles using the following steps:

- First, resources were read and annotated;

- Next, by employing a framework analysis approach (Pope et al., 2000; Ritchie & Spencer, 1993), open coding and mapping techniques were used to locate and connect data elements to corresponding principles of Minimalist documentation;

- Lastly, findings from this analysis were triangulated with users’ experiences from interview data collected for this study (i.e., methodological triangulation) (Denzin, 2007).
4.3 Comparing End-user Support for an Open-source and Proprietary EMR

As described in the introduction, this thesis is a replication of a multiple case study (Case Study A) that examined support for a commercial EMR in 4 Ontario FHTs. This thesis, on the other hand, examined support for an OSS EMR in an Ontario FHO, which provided a critical case for comparison with the original study. The main methodological details of Case Study A have been described earlier (p. 4).

To answer the third research question, main themes identified from all 5 settings included in both studies were collated and reviewed together in an attempt to identify key differences and similarities between:

- Models of primary care (FHTs and FHOs);
- Contextual factors (e.g., affiliation with hospitals) and;
- Support for an OSS and proprietary EMR.

Once again, to ensure trustworthiness, the supervisor of this thesis independently compared some of the themes, which were then discussed by the two researchers.
5  Findings

5.1  Case Study of an OSS EMR in a Semi-rural FHO

5.1.1  Participant and Setting Characteristics

A total of 11 users (4 physicians and 7 administrative staff) from the FHO relied on the EMR for their day-to-day work routines. Of these users, 7 agreed to participate in this study (3 physicians and 4 administrative staff). At the time interviews were conducted, the EMR (accessed through an application service provider-ASP) had been in operation for 12 to 14 months—6 participants had been using the EMR since it was first adopted; 1 for less than a year. These characteristics are summarized in Table 4 below. With the introduction of the EMR came a new set of expenses, which were shared amongst the clinic’s physicians and included:

- The acquisition and maintenance of the open-source EMR software;
- hardware expenses (e.g., initial costs and maintenance) associated with the EMR and;
- EMR training.

Other characteristics of the FHO included:

- The availability of in-house technical support person (on-call);
- No affiliation with a hospital, thus not having access to technical support from a hospital IT unit;
- The sharing of on-call duties among physicians and;
- The sharing of patient records among physicians.
Table 4

*Descriptive statistics of interviewees for case study of OSS EMR in a semi-rural FHO*

<table>
<thead>
<tr>
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<tr>
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<table>
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<tr>
<td>&gt;12</td>
<td>0</td>
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<tr>
<td>Unknown</td>
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| Total | 7     |

* Includes experience with any EMR system
5.1.2 Findings from Case Study of an OSS EMR in a Semi-rural FHO

Findings from this case study are organized according to the framework for analyzing the impact of end-user support on EMR success described above and recapitulated in the schematic figure 3 below. Firstly, comments related to system quality (e.g., the usability, information architecture and interoperability of the system) and information quality (e.g., the consistency, completeness, and accuracy of patient information) are described. Secondly, findings related to the individual impact of the EMR (e.g., impact on workflow and workload) and its subsequent impact on user satisfaction are described. Thirdly, the organizational impact (e.g., organizational communication and efficiency) and patient care impact (e.g., preventive care and monitoring of patients with chronic conditions) of the EMR are presented. Lastly, findings related to the independent variables of this study (i.e., support sources, characteristics and activities) are outlined.

5.1.2.1 System and Information Quality

Some users expressed frustration over the poor usability of the EMR. For example, a physician described the following bottlenecks in the system:

The software…hasn’t been a very efficient system and there’s been a lot of mouse clicks to get from one screen to another to implement this or to send a bill. When they [the administrative staff] do their billing, they’ve got a mouse click through about 3 or 4 or 5 screens… Even when I write a prescription or I print something for a patient, there’s 3 or 4 [screens to go through]– if I print a lab report there’s about 3 or 4 different mouse clicks. I can’t just right click and it comes up. If I click, it goes to another screen and brings down the file. I click again – I’ve got to click about 4 times to get a file printed, which just isn’t….. It isn’t user friendly…It just isn’t what I’m used to or would have expected with a program like this (E.1.2).

An administrative user made a similar observation: “there’s supposed to be a hospital billing system and it doesn’t default like it should. Like it takes us 12 steps to do a hospital bill and stuff like that. So, it’s….it’s……we’ve got to look into that” (E.5.2).
Difficulties associated with the interoperability of the EMR (i.e., the ability to communicate electronically with local pharmacies and hospitals) were also reported by users. For instance, concerning the interoperability with a local pharmacy, one physician observed:

The prescription module has some challenges. Hopefully they will work on that over time because, I mean I’m sure I gave grey hairs to the Pharmacist in town because some of the scripts that would get printed out were pretty bizarre coming off the module and you always have to double check and read it and then sort of delete it and go back and re-do it, so there was – and part of it was us and part of it was just, it’s just a quirky system (E.1.1.).

Users also described some of the non-technical issues affecting the interoperability with a local hospital. According to one physician:

“Yeah, the hospital is very reluctant to get involved with being able to transmit information in an electronic way, okay - their information to our EMR system. Until Ontario MD [stepped in] and then it became whether they were sold the fact that it was of benefit to them, less paper or whatever, but all of a sudden they became interested and then we got this fax transmission, which we’re hoping is going to be easier (E.1.2).

Similarly, an administrative user cited physicians’ age as the cause of their reluctance to exchange information electronically with the hospital:

Physicians in this office are not young. They’ve made a HUGE leap forward in using computers…But it’s been somewhat of a dig in the heels… And it’s almost like fighting each step of the way. We’re currently – the system is set up to have faxes come in automatically to our EMR, but we haven’t got there yet and that’s not the receptionists – or it’s not the secretaries not wanting that. It’s the physicians not wanting to go there (E.5.1).

The same user also had this to say about physicians’ reluctance to implement some of the EMR’s more advanced capabilities: “I think there are certain features that if we pushed ahead with it, it would make our jobs even easier, but we have to get past this – I don’t know what the word is –
reluctance to try new things. And it’s not our place to implement the system. It has to come from the physicians because ultimately they’re the ones that pay for it” (E.5.1).

On the day of the following interview, the clinic had established the connection to exchange information electronically with the local hospital; an administrative user described some of the initial challenges:

Okay, well, because I just had to phone them this morning because I’m not receiving faxes over the fax… Now I’m getting faxes again instead of going into the computer and I’m still waiting for him to call me back… See, but now this is my first time phoning in probably over a year, but it has to be fixed NOW, not tomorrow – NOW!. I’m tired of waiting for him –… They’re busy, I mean, you know, they’ve got lots of clients, but if they’re that busy maybe they need more help (E.5.4).

Another interoperability issue, which had implications for the accuracy of information, was the inability to migrate patient data from external health information systems in a reliable manner. As one physician recalled:

They [the EMR provider] said …they’ve done some transitions between [the EMR in question and an external HIS]…but they said the data transfer is inaccurate, very inaccurate. So there’s some big missing loopholes, so that you really almost need the paper documents to look at to make sure that what goes from [one system to another is accurate]… it’s a pretty inaccurate sort of thing – also quite expensive (E.1.1).

Elaborating on this point, this physician also noted that, “I’m not even confident with 23 providers in the province of Ontario that I can transfer records and when a new patient comes in or a patient goes somewhere else there is no assurance that those records are going to be easily transferable and it’s like the Tower of Babel, okay? It’s going to come down around our ears” (E.1.1). These findings are summarized in the table below.

5.1.2.2 Summary

Themes related to system and information quality included:
• The poor usability of the EMR;
• Problems with the pharmacy ancillary;
• Non-technical issues affected the EMRs interoperability with a local hospital;
• The inability to migrate patient records in a reliable and accurate manner.

These, however, were not the only findings related to information and system quality, which due to their close affiliation with other constructs from the framework will be described in the sections below.

5.1.2.3 Individual impact and user satisfaction

At the individual level, users described both negative and positive impacts of the EMR. Beginning with the negative impacts, both physicians and administrative staff agreed that the EMR slowed down clinical workflows and increased users’ workload. According to one physician, “I actually ended up working extra time in the office because I just couldn’t see the same [number of patients]… I had this volume of practice that was there and in the given hours… I couldn’t do it when I was in the EMR” (E.1.1). Similarly, a user with an administrative role remarked, “it’s [the EMR] affecting our time…It’s taking us a lot longer to do things that normally…you shouldn’t have to take that long to do” (E.5.2).

Participants also described the EMR’s impact on patient-provider relationships. As one physician noted, “when I first started, my concern was that I was spending more time worrying about trying to deal with this [the EMR] than…the patient…But I think that has ameliorated with time… I guess if I was a real sophisticated typer [typist] and stuff, because I’ve talked to young people and they – I used to talk to patients and just write with the pen as they talked and they can do that typing. So they had a level of sophistication that I don’t have” (E.1.1). An administrative user also commented on the impact of the EMR on patient-provider relationships: “I think since we’ve gone electronically it takes away from the patient-doctor relationship. I know in time everybody has to do it and…we have to do it, but I think it takes away from the doctor and the patient communicating because the doctor has to be on the computer all the time and I have heard that from patients” (E.5.4). Generally, this impact was not a significant source of
dissatisfaction among users since they tended to attribute it to user characteristics such as age and IT skills and not necessarily to the system itself.

Difficulties associated with the interoperability of the EMR (i.e., the ability to communicate electronically with local pharmacies and hospitals) also increased users’ workload. For example, a physician described an incident where patients’ lab reports were being received in both electronic and paper formats. As a result, the physician had to verify both reports in order to ensure that there were no discrepancies. In his words, “I had to go through and cross reference, which is more work...So when the paper came in I had to go and make sure that [it] was in the electronic record as well and that it was the same patient, the same tests, the same results and ...[it was] terribly cumbersome” (E.1.2). Similarly, an administrative user noted that, “We get...hundreds of faxes a day. This should all just be going into their EMR inbox and then being designated. So no paper would be printed. Right now we’re printing the paper, scanning it in. It’s ... an unnecessary step...If the system was being used the way it should, those faxes should come into the inbox” (E.5.1). Thus, it seemed liked the lack of interoperability between the EMR and local hospital/lab systems increased user’s workload, which contributed to users’ dissatisfaction.

The usability and information architecture of the system also had an impact on users’ workload. For example, during an interview a physician launched the EMR and walked the author of this thesis through its generic system for classifying patients’ test results. During the walkthrough he remarked that, “sometimes you have to go in and open things to know what’s in there. For example … I had a patient who had.....chemistry, chemistry, chemistry, chemistry, chemistry. Okay, I don’t know whether those are blood sugars, whether those are electrolytes. One of those is fecal occult blood. I have to open every one of those to know which one was his fecal occult blood and when it was done” (E.1.2). After recalling this experience, the physician remarked, “it’s [the EMR] not helpful. It’s not productive. It doesn’t save me time. It costs me time. And that’s not what this should be all about” (E.1.2). While the poor information architecture of the EMR seemed like a source of dissatisfaction for some users, this may also have been the result (at least in part) of the clinic being in a state of transition from a paper-based to electronic medical record system. As one physician recalled:

And the other thing is ‘save your favourite scripts’. So you have a bar where you can save favourites – and you just have to click on them. So once you get through that
honeymoon period you can get much more sophisticated and it is very helpful, and certainly some of the patients that are coming back now that I have everything digitized, it makes that interface a lot more tolerable (E.1.1).

Issues related to the operating system and hardware supporting the EMR also increased users’ workload. One administrative user recalled an incident where the computer of one physician’s office, running on an incompatible version of their operating system, was unable to print certain EMR forms correctly. Consequently, the forms had to be printed by another physician’s office which interrupted their workflow and increased their workload. Recalling the incident in the present tense, an administrative user from the assisting office noted, “I have to stop what I’m doing to do that. So it’s doubling up the work load. It’s just that the flow is not there” (E.5.1).

At the individual level, users also described more positive impacts of the EMR—namely for work flexibility. For example, physicians described logging into the EMR and checking lab reports while on vacation or during work-related travels. Upon remotely reviewing lab reports, physicians were able to delegate related tasks to their staff which reduced their workload upon returning to the clinic. Describing this impact, a physician remarked, “I can do a whole lot of things that historically I have not been able to do. So you know what, it’s pretty impressive from that standpoint” (E.1.1). This impact was a notable source of satisfaction, particularly among physicians.

### 5.1.2.4 Summary

Themes related to the individual impact of the EMR and user satisfaction included:

- Older users felt that their age and lack of IT skills prevented them from using the EMR efficiently;
- The impact of hardware problems on users’ workflow;
- The impact of interoperability issues on users’ workload;
- The impact of usability issues on users’ workflow;
- Work flexibility.
5.1.2.5 Organizational and patient care impacts

Users noted the EMR’s positive impact on communication between staff and with patients. In the words of one administrative staff member, “it’s [the EMR] made a tremendous help to our workload in terms of…talking to the patients, communicating between the physicians and the receptionists. I think it’s made a lot of difference that way. It’s made things a lot easier” (E.5.1). This impact seemed tied to users’ ability to efficiently retrieve and share information using the EMR. As another administrative user noted:

“It’s [the EMR] so much better…patients can go from…[one physician’s office to another]… I mean, that’s great that the patients can just go…wherever and it’s [their record] available. I mean, before we had an EMR we used to have to print out sheets of paper and the doctor could only deal with that issue and we would have to then go back to the filing to find our previous visits, if it was connected to a previous visit. But this is great. We just – the chart is right there for them” (E.5.3).

A third user, also with an administrative role, noted that, “It does make things a little quicker, and now that we can all sort of see each other’s patients, if somebody phones when the doctor is away then we can go in and look on their chart to give them help, let them know what’s going on” (E.5.4).

The EMR also impacted the clinic’s already moderate volume of patients, which had potential implications for 1) access to care and 2) physician incomes. Although physicians acknowledged high volume practices are undesirable (for it diminishes the quality patient care), they felt that their ability to serve previously registered patients was hampered by the EMR. As one physician put it, “the other issue [is] that doctors… – especially in my age group – that [are] going…EMR means reduced productivity on a daily basis, because they cannot process the same number of people through the office” (E.1.1). On this topic, an administrative user said, “we used to see 50 patients a day and now we see – we aim for like 36 a day. So that’s….you know….14 patients a day over 4 days….you know, you’re seeing 60 less patients in a week than you used to see” (E.5.2).
With regards to the more direct impact of the EMR on patient care, it seemed as though the potential to improve the coordination of care was not being realized. According to one physician:

I think once everything is in and I am sort of well versed, then I think there is a dimension to the practice that heretofore paper couldn’t provide. The issue will be if – and I know the connectivity in Ontario is getting better, so that we are tied into the hospital and the hospital has digital outreach to other hospitals for CT scans and MRI’s and a lot of studies. So I can see that in the province at some point of time in the future, I could be in my office and access with consent a lot of different information that might be out there on a patient, which would probably make my ability to intervene more cost effective, but probably more accurate too (E.1.1).

Referring to preventive care measures administered by the province of Ontario (e.g., pap smears, mammograms, fecal occult blood tests, immunizations for children, etc.), the same physician remarked:

All of those things are pre-prescribed things in terms of basic standards of care, to sort of monitor that and there’s pretty clear guidelines from sort of the clinical sciences that tells us where we should be interfacing on that. So, if you can press a button and pull out a population of people who haven’t had that done, I think that’s probably better medicine from a standpoint of yes, those people shouldn’t be falling through the cracks. So, I think from that standpoint the EMR taking you from paper to EMR, being able to do that is just – obviously labor saving and your productivity goes up immensely because you can do that. So as we get more sophisticated on what we want to screen and do, I think this kind of thing – you have to be on EMR because if you’re not, I don’t think you’re in the game (E.1.1).

In other words, users believed that EMRs can play an important role in the provision of better quality patient care. Although EMRs can (and do) play a vital role in this process, the clinic in question had yet to fully implement these capabilities. As one physician remarked, “in fact I think you have to have that [preventive care] …even for…billing. Because a lot of the component of preventive medicine…you’re being remunerated for in general practice – I mean we’ve been doing it by hand, but as I get my preventions all put in and those critical populations
all put in, we will be able to generate a lot of that by pushing a button to see who hasn’t been
looked at in that sense” (E.1.1). Another physician felt that, “there are lots of potential benefits to
the system if it was more universal and more accessible.....and if it was easier to access in some
ways. As it exists now, it’s simply a ….data collection system” (E.1.2). An administrative user
seemed more optimistic about the EMR’s impact of patient care. In her words, “I think maybe
the data might be a little more accurate because you’re able to put in pap smears, mammograms,
all that sort of stuff so you can sort of keep track of it and know when to call your patient back. I
think that’s a good thing” (E.5.4).

Problems associated with the interoperability of the EMR had potential consequences for patient
safety. For example, one physician recalled an incident where, unknowingly, incoming lab
reports were not being received through the EMR:

Well, it is a major patient issue in terms of management of patients at risk...For an
example, I got a hemoglobin back on somebody who had a hemoglobin of 69, that I
didn’t see for a week. The paper finally came across my desk and I said, ‘My god,
this guy’s bleeding to death’. So yes, there are – and I know – for my
understanding, I’m not sure that there is a software system out there that does that?
That checks what the doctor orders against what’s been received, but it’s an
interesting – because the lab providers have had their own set of problems on that
basis. So there is a medical legal risk and I think the issue is that – we write it on the
college notes and the college notes says that we must receive it either in paper or
digital to be accountable for that. So that if it gets lost in the system and something
untoward happens to a patient, but I didn’t get it, then I’m supposedly not
accountable, but......I don’t know.....I don’t necessarily want to be the guy who has
to get tried on that (E.1.1).

Another physician recalled the same event:

Yeah, there was a lot of confusion, I think and it was also not without some liability
because I mean, if somebody had a blood test done and it was abnormal and we
didn’t get the report back, we didn’t know that they had the blood test done. For
example, if somebody gets an INR done – you’re familiar with that – and it comes
back at 7 or 8 and I’m not notified, then you know, first of all I don’t know they had
it done until I get the result and if I don’t get the result then they’re out there with some abnormality. Now, if they have really abnormal results the lab usually phones… If it’s outside the life threatening limits they’ll usually phone, but otherwise we had a whole situation here where people’s results weren’t coming in and nobody seemed to be aware of that (E.1.2).

Another issue with potentially negative implications for patient safety was the poor usability of the EMR. The EMR failed to capture combined immunizations and continued reminding users that patients required some of the immunizations, even when it was given. As one administrative user recalled, “that’s another glitch from the system too because it doesn’t pick up the combination with the shots. So it’s still telling you that they need shots, but they’ve actually had them” (E.5.2). This issue, according to the user, was further complicated (somewhat paradoxically) by the EMR being used as a tool to coordinate care amongst physicians. In the user’s words, “you could be giving them double the shot if you didn’t know that that was a [false reminder] – if a new doc came in here they’d say, ‘oh, they need the shot’” (E.5.2).

5.1.2.6 Summary

Themes related to the organizational and patient care impacts of the EMR included:

- The EMR facilitated organizational communication;
- A drop in clinical productivity (i.e., volume of patients);
- Interoperability and usability issues had potentially negative consequences for patient safety;
- The EMRs preventive care chronic disease management capabilities were not fully implemented.

5.1.3 Support Sources, Activities and Characteristics

5.1.3.1 Informal support

Informal on-site support played a key role in ensuring the quality of information. For example, lab requisitions and referral templates were automated (also known as e-forms) by one of the
physicians’ daughters. She also assisted with the initial digitization of paper-based medical records. The physician in question described his daughter’s role as follows:

My daughter saved our bacon because she...actually took all the templates from the hospital lab, all the requisitions and she actually put those into the [the OSSEMR] system for us. And we have probably a template of probably 20 or 30 physio forms, diabetic clinic, standard lab stuff that we would order on a regular basis, physical lab stuff – so that’s all templated in. Now if she hadn’t been around I think we really would have floundered and it would have cost us a ton of money according to our medical advisor, practice management people. So that there’s a really big hole in that transition from going away from paper to electronics (E.1.1).

In addition, the physician’s daughter learned how to automate requisition forms through the OSS EMR’s online society of users. Using this resource, she was able to connect with another, more advanced, user (a physician in this case) who taught her how to create e-forms. Her father described the process and some of its implications:

My daughter had to go online and talk to [OSSOS EMR] users… and she found somebody in Sudbury that was an MD that had an interest in EMR and he told her how to do it. So she actually learned from that, but our actual software provider was very lean on sort of some of those basic sort of things to make the transition into the system, and the grant money they suggested from Ontario MD that there was federal money to support EMR and sort of mentor doctors that use systems – they’re having trouble finding a mentor that’s an [name of EMR] sophisticated doctor who is going to come out and do the on-site help for us. So we haven’t been able to avail ourselves of some of the federal funds on that basis too. So, it’s been a bit of a box (E.1.1).

This comment also captures users’ dissatisfaction with formal support sources (e.g., the EMR service provider and provincial health IT bodies) and the importance of on-site support in relation to data quality. Since the physician’s daughter was unavailable to provide data support on a full-time basis, she created a tip-sheet on creating e-forms for the office (the extent to which this was used is unknown). Describing this tip-sheet, one user recalled, “that’s [the tip sheet] like if you want to put a platform into the system. It’s complicated. It takes about 3 hours to put one form in, but the tip sheet, [a physician’s] daughter made up for me because she’s the one that did
all of our forms when she was here the first 3 months” (E.5.2). The physician’s daughter also assisted with the digitization of paper-based records during the initial phase of EMR implementation. In her father’s words:

Well, I had my daughter doing it [digitizing patient records] and she saved my bacon because she was in transition between doing sort of – she’s a scientific journalist that actually worked at Yale in terms of their nutritional systems and handled a whole lot of their public relations and their websites and all that sort of thing. So she was pretty savvy. So she came for about 2 months in our first transition to...to EMR and probably actually saved the clinic’s bacon in terms of the transition because there are some real holes in terms of trying to make that move. So, she sort of got me started (E.1.1).

The “champion” of the EMR, a technologically adept physician who played a leadership role in transforming the clinic to an EMR system, also outsourced informal support for the digitization of patient records.

Another connection between informal on-site support and information quality was the development of data entry conventions. Walking the interviewer through the EMR’s laboratory ancillary, one physician made the following observation:

If you go back up to other things, these documents, when we scan in a document then we label it. So it depends on how my secretary chooses to label – This is a gallium scan that came back, which is a result... Now initially they were putting in the date as the date they did it, rather than the date that the scan was done. So that’s our protocol that we have to establish to know and, you know, that can be problematic in terms of trying to sort through and sort this sort of stuff. So anytime you get a list like this, so I open this list up and I’ve got stuff in here going back – so as I go through here and try to find something, that’s going to depend on how effectively it was labeled, the date that it was – and for me I’ve said I want the date that it was done, not the date that we put it in...So what’s happening now with this gallium scan, that will now come into our fax line rather than come in as a piece of paper and then it will come into an inbox file. My secretary then puts it into the
patient’s file and forwards to me and then I have to acknowledge or approve that, but that will come in without the paper…How you label these is important (E.1.2).

Although physicians and their respective administrative staff had developed data entry conventions, absent was a practice-wide strategy for ensuring data consistency. As one physician observed:

Everybody sort of puts data in a little bit differently. I mean, we’re in a group here so we share the electronic system. I can access…my colleagues’ patients, but how they enter data and how they label it – everybody sort of has their own nuances in terms of what they call – if we have an operative report that comes back it may get called something a little bit different depending on whether it comes through my office…there’s no real format in terms of how that’s labeled (E.1.2).

5.1.3.2 Formal Support

All users described the importance of support that was prompt and delivered by knowledgeable staff. As one physician described:

If I had to say what is important in a support person, they have to be knowledgeable, accessible and responsive. Okay? I have to be able to get a hold of them when I need them and when I try to get a hold of them I need them to get back to me. Those are the things that I would value in a support person. Knowledge, accessibility and responsiveness (E.1.2).

The importance of prompt support and knowledgeable support staff also seemed tied to users’—and by extension the clinic’s—reliance on the EMR. Commenting on this issue, a second physician remarked:

Knowledgeable and timely, because I mean once you’re up and running and you’re committed to the system, if you have problems they have to be solved quickly and they have to be available and those are pretty critical because it’s like everything else, time in motion, right? If you’re there and you can’t do things, it becomes a real dilemma (E.1.1).
This physician was skeptical about the EMR service provider’s ability to deliver prompt and knowledgeable support; in the physicians words, “we can phone our software service provider and they will eventually get back to us, but it’s not always as timely as probably our staff [would like]” (E.1.1.). Recalling another incident involving missing lab results, the physician remarked, “so we don’t have any real knowledge of, if I’ve ordered something on a patient, do they actually go and get it done and is there a complete circle on whether that is – if it’s been ordered, does it come back in? And our software people say, ‘well, we don’t know how you’d ever conquer that?’” (E.1.1).

Users described the usefulness of formal support provided through remote access. In the words of one administrative user, “I mean, in this day and age with their new improved [the open-source EMR system]… they can come into the computer. They can see what we’re doing. So they have remote access. That’s tremendous” (E.5.1). Nevertheless, users still stressed the necessity of in-house support. As another administrative user described:

I would rate it [formal support from the vendor] as poor and I actually sent them documentation to that effect…because they should have been on-site Day 1…to help us the first couple of days…We were thrown into the EMR and that computer on the first day. None of us had ever worked Macs and none of us had, you know, like we had a half day training session, but on the first day live we needed somebody on site because it was just little things that were easily overcome, but we couldn’t do them (E.5.2).

Describing a situation where off-site formal support proved insufficient, another administrative user stated, “yeah, because then [upon arriving to the clinic] he could see that in fact, yes, there must be a glitch in our system and he got right on the phone and called his IT guy who fixed it that night, but for like 3 weeks we had been saying that there was a problem. ‘Oh, well, you’re doing it wrong!’” (E.5.2.). A similar comment made by this user reveals a potential link between on-site support and empathy—which is a determinant of effective support outlined in the literature review. Describing an issue requiring formal support, the user stated:

Very condescending [off-site formal support], because for example, when we were doing the reconciliations when it first started, like it’s all hit and miss… [The attitude of a formal support person was] ‘well, that can’t be right. That can’t be the
way you’re doing it!’...All three offices were running into the same problem. So when he came [on-site] he said, ‘Oh, there is a problem here.” Yeah, like it wasn’t us. It was [a glitch in the system]... [The support person realized this] when he came and saw that, yeah, he couldn’t do what he was telling us to do” (E.5.2).

Due in part to the clinic’s reliance on the EMR for day-to-day operations, users highlighted the importance of local IT support for resolving hardware issues. As one physician noted:

There’s not – I mean, there’s always...hardware glitches and stuff like that, but that’s just the world of EMR and hardware and software interfaces and that sort of thing, so, that’s just not necessarily what system you pick. (NO). I think the issue is if you go into EMR you better have not only a good software vendor, but you also better have somebody good in IT that can troubleshoot your office for you, because if you’re down, it’s a problem (E.1.1).

Satisfaction with formal sources of support may also have been affected by contextual factors such as a) the fragmented work culture of the clinic and b) the rapid market growth of the EMR provider. With regards to the former, the EMR provider seemed to prefer dealing with a single point-of-contact within the clinic, which seemed like a source of frustration for other users—particularly administrative staff supporting their respective physicians’ offices. Commenting on this issue, one administrative user recalled:

Ongoing support, um, I find they like to deal with one person. They don’t like to deal with me. So I have a very – they don’t get back to me very fast. So the support from the provider is not good...If I was to email them with a concern, something that wasn’t working, they would phone the other office and give them the answer or give them the – tell them how to do it. Like they don’t – they didn’t realize – like they knew that we were individual offices, but things were not working for some but were working for others (E.5.2).

Users were also aware of the EMR service provider’s rapid market growth and its impact on the quality of support services. As one user recalled,
For me – for support staff. They had workshops during the day about different features of the program – billing, scheduling, just all different features of it that if you had questions there were resources there to ask people. Overview about upcoming features, upgrades to the version that we had.....also an explanation as to it explained why the support that I thought was really poor, why it was that way and you know, their explanation was that [the EMR service provider] had just grown so big. They’d gone from having such a small market share to being this huge EMR provider province wide and they just didn’t have the.....the people, the staff to keep up with that (E.5.1).

5.1.3.3 Training, Education and Functional support

Most users felt as though they were not using the EMR to its full potential and that services encouraging learning and exploration of the system were wanting. According to one user:

“Hopefully we’re using it efficiently. I mean, I think there’s probably an awful lot of features that we have NO IDEA what to do with because we don’t have that training and it’s....it’s just one of those things that if you don’t – if you don’t know it’s there, you don’t use it and to find the actual time to go in and find, ‘Well what exactly does this do and how could we use it?’ We don’t have time” (E.5.1).

Elaborating on this point, the user said the following:

That [functional support] actually should come from our [EMR] provider… I think realistically after you’ve been using the system for a while there should be a return visit from them to investigate how we are using the system and even just to stand back and watch over shoulders and say, ‘Ah, wait a minute. Why are you doing it that way? Look, you could do this.” You know, I think there’s....I think there’s a lot of shortcuts in there that we don’t know about and I think they – they need to come back and show us that (E.5.1).

In other words, this important observation, which is representative of the general user population as well, captures users’ desire for ongoing, formal, and onsite support that encourages users to learn more about and explore the functional capabilities of the EMR.
5.1.3.4 Summary

Themes related to informal support included:

- Outsourcing informal data support for creating e-forms;
- Obtaining support through an online community of users;
- The absence of practice-wide policies or procedures for ensuring data consistency.

Themes related to formal support included:

- The need for knowledgeable and timely support;
- The impact of the service provider’s market growth on service quality;
- Unequal access to formal support.

The significance of these findings is further explored in the discussion section of this thesis.
5.2 Comparing User Documentation for an OSS and Proprietary EMR

A total of 4 support documents and one section from the OSU website were analyzed for this segment of the study; their main characteristics are outlined in Table 5 below. Findings from the analysis of these sources’ sections on e-forms, which were organized according to the principles of Minimalist documentation, are now described and summarized in Table 8 at the end of this section.

Table 5

Characteristics of impersonal sources of support

<table>
<thead>
<tr>
<th>Source</th>
<th>Length</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unofficial document for OSS EMR</td>
<td>Short (5 page) document</td>
<td>- No table of contents or index</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Dedicated solely to e-forms</td>
</tr>
<tr>
<td>Official open-source EMR user manual</td>
<td>Long (189 page) manual</td>
<td>- Table of contents (no index)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Instructions on a full-range of administrative and clinical EMR functions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 10 pages dedicated to e-forms</td>
</tr>
<tr>
<td>Online society of users (OSU) for open-source EMR</td>
<td>Page entitled “eForms”</td>
<td>- 4 hyperlinks:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1) “Instructions on how to upload forms”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) “eForms for download”;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) eForms in development;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) eForm Building Resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The page’s sidebar contained links to user blogs, listservs, a live demonstration site, and independent support providers</td>
</tr>
<tr>
<td>Official proprietary EMR user manual:</td>
<td>Long (382 page manual)</td>
<td>- Table of contents and index</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Instructions on a full-range of administrative and clinical EMR functions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 11 pages dedicated to “custom forms”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Table of contents and index</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Instructions on a full-range of administrative and clinical EMR functions</td>
</tr>
</tbody>
</table>


administrative and clinical EMR functions.
- 1 page dedicated to the use of “custom forms”

5.2.1 Action-oriented approach

The user-generated document for the OSS EMR began with procedural (i.e., action-oriented) instructions straightaway. For example, the document instructed users to create a folder entitled “e-forms” on the system’s desktop. The following instruction was to upload a Cascading Styles Sheets (CSS) file for generating e-forms to the folder (a hyperlink to the file was also embedded in the instruction). The document also provided users with an alternative method for creating this folder (e.g., copying and pasting a folder from a shared drive).

In comparison, the official OSS user manual began with more descriptive or “declarative” information. For example, the manual began by describing the EMR’s open-source/individual-oriented design and how such features supported users’ adaptation of e-forms to local requirements. The manual then proceeded to describe, rather than provide procedural steps for creating, e-forms.

The OSU began with a minimal amount of declarative information about e-forms (i.e., two short sentences explaining their purpose). The first link “Instructions on how to upload forms”, directed users to a list of Hypertext Markup Language (HTML), CSS, and Portable Network Graphics (PNG) files containing e-forms for download, modification, and use. For many of these listings, appended were the names of authors and the clinic’s they were created for.

Conversely, the e-forms section in the official manual for the proprietary EMR began with a note declaring the need for clients wishing to build custom forms to either a) purchase a separate module for generating custom forms or b) hire a vendor-provided technician to build custom forms on their behalf.

Finally, the user-generated manual for the proprietary EMR also declared the need for users to have undergone formal training prior to creating custom forms.
5.2.2  Anchoring the tool in the task domain

All sources contained instructions on how to create e-forms. However, there was variance in the degree to which the information in each of these sources was adapted to the specific context of the users.

The user-generated document for the OSSOS EMR contained site-specific and step-by-step instructions for creating e-forms (e.g., instructions involving paths to specific folders on the clinic’s shared drive). This document also advised users to download a browser with open-source components for running the e-form generator (according to this document the default browser could not execute this file properly).

Unlike the previous document, the official OSSOS EMR user manual did not contain any information pertaining to e-forms that could be construed as context-specific.

The OSU did not provide site-specific information on the creation and use of e-forms, but rather provided users with HyperText Markup Language (HTML), CSS, and Portable Network Graphics (PNG) files containing e-forms for download, modification, and use in the EMR.

The official proprietary EMR user manual did not contain any information pertaining to e-forms that could be interpreted as context-specific.

The user generated manual for proprietary EMR manual listed the clinic’s Patient Care Manager and Medical Director as contacts for receiving formal training on e-forms, but no site-specific information on their creation and use was provided.

5.2.3  Error information

The user-generated document for the OSS EMR contained basic information intended to prevent errors; however, this information was not distinctive from the surrounding text.

The official OSS EMR user manual also contained some basic preventive error information, some of which was written in capitalized letters, thus making it more distinct from the surrounding text.
The OSU contained a link entitled “Tips on using the e-forms” which contained some basic error information. For example, solutions for glitches around uploading and using e-form templates were listed by their authors. In addition, the page’s sidebar contained links to user blogs, listservs, a live demonstration site, and independent support providers which could most likely assist users in troubleshooting errors related to e-forms.

The official proprietary EMR contained some basic error information on the use of custom forms that was distinct from the surrounding text (e.g., used bold headings entitled “Note”).

In the user-generated manual for the proprietary EMR, the main instruction was for users to seek formal training on the use of custom forms. Thus, including error information was beyond the scope of this section.

5.2.4 Support reading to do, study and locate

Arguably, the short length of the user-generated document for the OSS EMR is indicative of its alignment with this principle. The content of the document was more procedural (i.e., supporting reading to do) than declarative, which significantly reduced its size. While this may have rendered the document more useful, the task of creating e-forms itself remained time-consuming. As one administrative user recalled, “it’s complicated [creating e-forms]. It takes about 3 hours to put one form in, but the tip sheet [physician’s name] daughter made up for me [helped]… I have only put in one thing in the last year because I don’t have time to sit and do the 3 hour input”. The author of this tip sheet generated its content, at least in part, by connecting with more experienced users via the OSU.

Although the official open-source EMR user manual remained focused on a broad range of EMR functions, users were still discouraged by its length. When asked whether he made use of any support documentation, referring to this manual, one physician replied:

“There is a big user book. It’s a big manual. It’s oppressive in terms of its size. I don’t know where it is… With all the other things that I have in my life going, I just haven’t had time to sit down and crank through that and – and I’m not sure whether I’m sophisticated enough to really make that interpretation” (E.1.1).
Another physician made this similar comment, “we’ve got a training [manual]…I’ve never gone past the first couple of pages…it’s 181 pages” (E.1.2).

The OSU seemed to be structured around facilitating the sharing of files containing modifiable e-form templates, rather than providing descriptive information about e-forms, which had the effect of minimizing the source’s word count.

The length of the official proprietary EMR user manual (382 pages) is indicative of its discordancy with the principle of supporting reading to do, study and locate. The content of the document was more declarative (i.e., supporting reading to learn) than procedural information, which significantly increased its size.

Like the previous manual, the user generated manual for the proprietary EMR contained a table of contents and index. However, the user generated manual was significantly shorter in length (189 pages shorter), thereby aligning it more closely to the principle of supporting reading to do, study and locate.
5.2.5 Summary

The analysis of impersonal sources of support described above is summarized in Table 6. Findings from the analysis indicate that user-generated materials for the OSSOS EMR better fit the principles of Minimalist documentation in that they take an action-oriented approach, anchor the tool not only in the general task domain but also in the specific context of the site, and support reading to do, study and locate.

Table 6

*Impersonal sources of support and the principles of Minimalist documentation*

<table>
<thead>
<tr>
<th>Source</th>
<th>Action-oriented approach</th>
<th>Anchoring the tool in task domain</th>
<th>Error information</th>
<th>Supporting reading to do, study, and locate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unofficial document for the OSS EMR;</td>
<td>✅</td>
<td>✅</td>
<td>-</td>
<td>✅</td>
</tr>
<tr>
<td>The OSS EMR’s online society of users (OSU) (page entitled “eForms”)</td>
<td>✅</td>
<td>-</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>The official OSS EMR user manual</td>
<td>-</td>
<td>-</td>
<td>✅</td>
<td>-</td>
</tr>
<tr>
<td>The official proprietary EMR user manual</td>
<td>-</td>
<td>-</td>
<td>✅</td>
<td>-</td>
</tr>
<tr>
<td>A user generated manual from one of the Case Study A sites</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>✅</td>
</tr>
</tbody>
</table>
5.3 Comparing End-user support for an OSS and Proprietary EMR

In addition to the FHO recruited for this thesis, four Family Health Teams (FHTs) were recruited for Case study A. The following are the main characteristics of each of these FHTs:

- FHT A: a large FHT with more than 30 physicians distributed in multiple offices in a small town/ rural area; not affiliated with a hospital.
- FHT B: a small, co-located, FHT in an urban area with some affiliation with an adjacent hospital. This was a new FHT which started with the EMR from the time it was established.
- FHT C: a small FHT in a suburban area. The FHT has one main site and two satellite clinics. It had some affiliation with an adjacent hospital.
- FHT D: a medium size FHT, located in a large teaching hospital in an urban area.

Salient characteristics of FHTs selected for Case Study A and descriptive statistics of Case Study A interviewee characteristics are found in Table 7 and Table 8 below.
Table 7

*Salient characteristics of FHTs selected for Case Study A (from: Shachak et al., unpublished)*

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Site A</th>
<th>Site B</th>
<th>Site C</th>
<th>Site D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Large (&gt;30 physicians)</td>
<td>Small (&lt;10 physicians)</td>
<td>Small (&lt;10 physicians)</td>
<td>Medium (10-30 physicians)</td>
</tr>
<tr>
<td>Area</td>
<td>Small Town/Rural</td>
<td>Suburban</td>
<td>Urban</td>
<td>Urban</td>
</tr>
<tr>
<td># of Clinic Sites</td>
<td>&gt;10</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Affiliation with a hospital</td>
<td>No</td>
<td>Some</td>
<td>Some</td>
<td>Located within a teaching hospital</td>
</tr>
<tr>
<td>Time using the EMR (months)</td>
<td>&gt;24</td>
<td>&gt;24</td>
<td>12-24</td>
<td>&lt;12</td>
</tr>
<tr>
<td>In-house IT support</td>
<td>No</td>
<td>Some assistance from the hospital IT unit</td>
<td>Some assistance from the hospital IT unit</td>
<td>Support from the hospital IT unit</td>
</tr>
</tbody>
</table>
Table 8

Descriptive statistics of Case Study A interviewee characteristics (from: Shachak et al., unpublished)

<table>
<thead>
<tr>
<th>Site</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Profession</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physicians</td>
<td>9</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>RN</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>NP</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Allied Health</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Tech Support</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Training</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Administrative</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Female</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>11</td>
<td>29</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;30</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>30-39</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>40-49</td>
<td>8</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>50-59</td>
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<td>3</td>
<td>10</td>
</tr>
<tr>
<td>&gt;60</td>
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<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>EMR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experience**/time with vendor (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1-2</td>
<td>9</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>22</td>
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<td>3-5</td>
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<td>1</td>
<td>5</td>
</tr>
<tr>
<td>6-8</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>9-12</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>&gt;12</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17</td>
<td>7</td>
<td>5</td>
<td>13</td>
<td>42</td>
</tr>
</tbody>
</table>

** Includes experience with any EMR system

Overarching themes and differences between findings from this thesis and Case Study A are captured in Table 9 and described in further detail below.
Table 9

Findings from the comparison of case studies

<table>
<thead>
<tr>
<th>Topic</th>
<th>Common themes across sites and systems</th>
<th>Site and system-specific themes</th>
</tr>
</thead>
</table>
| ✔️ Support characteristics | - The importance of timely support delivered by knowledgeable support staff.  
                             - The importance of on-site support. | - No site and/or system-specific themes of any significance were observed. |
| ✔️ Formal Support | - Users relied on formal support to repair system quality issues (e.g., software bugs, interoperability and usability issues).  
                         - The rapid commercial expansion of formal support providers negatively impacted the quality support services (i.e., could not hire and train enough support staff to meet the needs of users).  
                         - Only in the FHO selected for this thesis did users report the uneven access to formal support services among clinical staff. | |
| ✔️ Informal support | - Informal support played a central role in promoting information quality. | - Only in the FHO selected for this thesis did users report outsourcing data support. |
| ✔️ Patient care impact | - System quality issues had implications for patient safety.  
                         - Information quality had implications for performing practice-wide searches and producing reports for preventive care and chronic disease management. | - Only FHTs had well-developed policies and procedures for ensuring data consistency, which facilitated practice-wide searches and reporting for preventive care and chronic disease management. |
| ✔️ Impersonal support (i.e., user documentation) | - Users were either unaware or made minimal use of official user documentation. | - Only in the FHO selected for this thesis did users report using an online community of users.  
                         - Informal/impersonal sources of support for the OSS EMR better fit the principles of Minimalism. |
5.3.1 The importance of local and on-site support

In all cases, users noted the importance of local and in-house support for both hardware and software related issues. For example, an administrative user from case D noted:

A help desk will just infuriate people because if they’re there and the patient’s there and they’re struggling with something, number one, they’re not going to want to call a help desk. They’re going to get a whole bunch of questions whereas if someone just sat down and you know, see this, click, click, click. So during the transition I think you really need on-site people (D.5.5).

The importance of local support was also apparent in case A. According to one physician, “the big thing they [unknown] need to add is local IT support to set up the network” (A.1.3). An administrative user from case A also noted, “we have requested funding from the MOHLTC every year for an IT support person…with the argument that we can’t get a lot of stuff done that needs to get done” (A.5.4). Case E users also highlighted the importance of local hardware support. According to one of the clinic’s physicians:

There’s not – I mean, there’s always…hardware glitches and stuff like that, but that’s just the world of EMR and hardware and software interfaces and that sort of thing, so, that’s just not necessarily what system you pick. (NO). I think the issue is if you go into EMR you better have not only a good software vendor, but you also better have somebody good in IT that can troubleshoot your office for you, because if you’re down, it’s a problem (E.1.1).

Lastly, as quoted earlier, an administrative user from the critical case study noted:

Very condescending [off-site formal support], because for example, when we were doing the reconciliations when it first started, like it’s all hit and miss… [The attitude of a formal support person was] ‘well, that can’t be right. That can’t be the way you’re doing it!’…All three offices were running into the same problem. So when he came [on-site] he said, ‘Oh, there is a problem here.’ Yeah, like it wasn’t us. It was [a glitch in the system]… [The support person realized this] when he came and saw that, yeah, he couldn’t do what he was telling us to do” (E.5.2).
5.3.2 Knowledge and timeliness of support

Since the day-to-day operations of clinics were dependent on the use of EMRs, users expressed the need for support to be prompt and delivered by knowledgeable personnel in all cases. However “knowledgeable” seemed to have several connotations, including:

- Knowledge of clinical work
- Knowledge of an EMR system
- Specific knowledge about a clinic and how it works.

In the words of one Case A physician: “He [a vendor-provided support person] was knowledgeable but he doesn’t think like a clinician, he doesn’t know how we need to use the software” (A.1.2). A case C physician similarly noted:

[support personnel] should have greater perspective on how physicians related to electronic medical records and, you know, instruct them in that spirit. What I’m trying to say is, you know, an individual may be technically excellent with computer software or the designer of that software, may not be the person who is best suited to instruct physicians on how to use it (C.1.2).

Early on, the leadership of Case D seemed to recognize these shortcomings and consequently developed their own methods for training and supporting EMR users. As one case D physician recalled:

So the first thing is we had the vendor come and do training. It became very obvious to us at the outset that we needed to actually customize the system for how we want it to be. The vendor training is generally quite generic…So we did, we trained a small group of super-users first and we made decisions on how to actually use the system and how we wanted it set up and then had the trainer train our staff in terms of how we wanted, how it was going to be set up for them” (D.1.4).

Regarding the promptness of support services, one case A physician remarked, “to be a successful family doctor you have to have the three ‘A’s’: availability, affability and ability…}
think the same for a support person, availability is the most important thing” (A.1.5). A physician from case E made a similar observation:

Knowledgeable and timely, because I mean once you’re up and running and you’re committed to the system, if you have problems they have to be solved quickly and they have to be available and those are pretty critical because it’s like everything else, time in motion, right? If you’re there and you can’t do things, it becomes a real dilemma (E.1.1).

5.3.3 Formal support, system quality, and patient safety
In all cases, users relied on formal sources to repair software bugs—some having potential implications for patient safety. For example, an interviewee from case A noted, “there are lots of warnings on the system but maybe too many; after a while doctors find it annoying because there are so many and so they ignore them; might be better to have a few warnings for critical things” (A.2.1). An interviewee from the critical case study also described software problems with potential implications for patient safety:

Yeah, and they’re going to work on that. So you know how you have the Diptheria, Tetanus and Polio – like the combination of 4 shots or whatever? It’s in the system, but it doesn’t pick it up as one. It’s still telling you that they need the group. You know, the primary series or whatever. It’s entered, but it doesn’t pick it up because it’s entered as a – it’s a different combination of drug now. So it’s saying they still haven’t had it even though it’s in that drug. They have a slot that calls the other drug up which includes it. So it keeps flashing saying that they need this, and they don’t (E.5.2).

When asked whether support for these issues was adequate, referring to the EMR service provider, the user replied, “no, because it’s been a year and a half now… because I mean that was from Day 1 that they [physicians] said this isn’t [working properly]” (E.5.2). Similarly, a case A physician recalled, “so problems don’t get fixed. We’ve got many little things that don’t make or break us every day, that haven’t been fixed for months despite the fact that we’ve called [the EMR vendor] 6,8,10 times to say ‘can you fix this’” (A.1.2). This, according to another case A physician, was the result of the EMR vendor’s
rapid market growth. In his/her words, “they’re growing too fast. Their IT people are inexperienced, in general they’ve changed- because I’ve used them for 20 years when they were [former name of vendor]- to being a company that was responsive to being a company that’s totally unresponsive to the issues” (A.1.3). An interviewee from case E made a similar observation:

For me – for [clinical] support staff. They had workshops during the day about different features of the program – billing, scheduling, just all different features of it that if you had questions there were resources there to ask people. Overview about upcoming features, upgrades to the version that we had.....also an explanation as to – it explained why the support that I thought was really poor, why it was that way and you know, their explanation was that [the EMR vendor] had just grown so big. They’d gone from having such a small market share to being this huge EMR provider province wide and they just didn’t have the.....the people, the staff to keep up with that (E.5.1).

5.3.4 Informal support, information quality, and preventive care

In all cases, users developed policies and procedures for promoting information quality (e.g., completeness and consistency); however, it seemed like case D was the most advanced in this regard. As one case D physician recalled, “we collated…about 50 or 60 forms that we use when I went through the unit to find out exactly all the different pieces of paper going out. Got those, made then all into electronic forms within [the EMR system] and we just go click, click, click and fax it out the system” (D.1.4). In contrast, case C struggled to develop standardized methods for data entry. For example, one case C noted:

physicians being like they are- I mean, if you put 8 of them together they’ll have 8 different ways to doing the same things, right. And, you know, very slowly, grudgingly, reluctantly, they start to come together and there develops a certain degree of standardization and over time, through trial and error, right, that’s starting to happen in our group (C.1.2).

A case A physician made a similar observation, that “if people don’t pay attention and put the stuff in incorrectly then the database is only that good- which is a shame though because if you
really want to be good researchers this is a great way of doing it, if you have you have people putting good information in, then you can draw lots of conclusions from it’’ (A.1.3).

As described earlier, data entry conventions were established between case E physicians and their respective clinical support; however, absent were practice-wide policies and procedures to ensure data consistency. As one physician observed:

Everybody sort of puts data in a little bit differently. I mean, we’re in a group here so we share the electronic system. I can access…my colleagues’ patients, but how they enter data and how they label it – everybody sort of has their own nuances in terms of what they call – if we have an operative report that comes back it may get called something a little bit different depending on whether it comes through my office…there’s no real format in terms of how that’s labeled (E.1.2).

In all sites except for case E, users described practice-wide, informal support practices for ensuring data consistency (further discussed in section 6.1 below), which is a prerequisite for using the EMR for preventive care purposes and managing patients with chronic conditions (e.g., performing practice-wide searches and producing reports). As one physician interviewed for this thesis observed, “there are lots of potential benefits to the system if it was more universal and more accessible…..and if it was easier to access in some ways. As it exists now, it’s simply a data ….data collection system” (E.1.2). Another case E physician noted: “in fact I think you have to have that [preventive care] …even for…billing. Because a lot of the component of preventive medicine…you’re being remunerated for in general practice – I mean we’ve been doing it by hand, but as I get my preventions all put in and those critical populations all put in, we will be able to generate a lot of that by pushing a button to see who hasn’t been looked at in that sense” (E.1.1). In contrast, a case D physician noted: “we have searched all of our preventative screening tests and see who’s up to date for them and who is not. Anyone who was not up to date was automatically sent a letter telling them that they were out of date for it and advising them to get the screening measure done” (D.1.2.).

5.3.5 Summary

Key similarities between the studies included:
- In all cases, users noted the importance of on-site support for repairing hardware problems and for training and education purposes.

- Independent of the setting and system, users relied on formal sources of support for technical problem solving (e.g., repairing software bugs, interoperability and usability issues). Some of these issues had implications for patient safety; for example, missing lab reports, excessive reminders (which created alert fatigue) and erroneous vaccination alerts were reported—all of which could have negatively impacted patients health and safety.

- Both propriety and open-source EMR users described their reliance on formal sources of support for technical problem solving; however, users of both systems expressed dissatisfaction with their vendor/service provider’s ability to solve such matters in a timely fashion.

Key differences between the studies included:

- A key difference between the studies was the positive relationship between clinics with well-developed, practice-wide policies and procedures for ensuing data quality and the ability to use the EMR for purposes related to preventive care and chronic disease management. This relationship was only observed in the FHTs examined for Case Study A and not the FHO studied for this thesis.

- Another difference was that only in the FHO selected for the critical case study did users report using an online community of users, which seems to be one of the main advantages of OSS EMRs. Furthermore, informal/impersonal sources of support for the OSS EMR better fit the principles of Minimalism.
6 Discussion

In all cases examined for this study, participants described several ways in which end-user support sources, characteristics and activities affect constructs from the DeLone and McLean Model of IS Success (1992)—which formed the theoretical basis for this inquiry. These affects, their broader implications, and the limitations of this study are discussed below.

6.1 Informal Support, Information Quality and Preventive Care

In every case selected for this study, users described the role of informal on-site support in relation to information quality. Information quality is a budding topic in HIS research (Häyrinen et al., 2008; Meijden et al., 2003; Yusof et al., 2008), and studies suggesting that it is affected by end-user support are beginning to emerge. For example, Lau et al., (2011) cluster the “responsiveness of support services” and the availability, accuracy, and completeness of clinical information within the “Quality of HIS” dimension of their Clinical Adoption Framework. Participants from the FHO selected for this thesis and the FHTs selected for Case Study A described a range of internally developed practices for promoting the quality of EMR information. These practices included:

- Developing practice-wide tools such as e-forms or templates to facilitate consistent data entry. In all cases, at least one person was responsible for creating and disseminating these tools;
- Adopting a standard terminology (FHT B from Case Study A);
- Programming reminders into data fields (FHT B from Case Study A);
- Auditing charts to ensure information was complete, correct, and entered consistently (quality assurance) (FHTs B, D from Case Study A);
- Establishing a committee to decide on data entry conventions (FHT A from Case Study A);
- Informal meetings/conversations regarding data entry practices (this study’s FHO).
- Developing tip sheets for creating e-forms (this study’s FHO);
- Developing an information management (IM) strategy during the initial phase of EMR implementation (FHT D from Case Study A).
Information quality is an important driver of HIS success. Clinicians can rely on EMRs to support clinical decisions if data are defined and structured; conversely, incomplete or inaccurate data are of significantly less value for statistical, health policy, research and decision-making purposes (Häyrinen, Saranto, & Nykanen, 2008); in their words: “the success of EHRs depends on the quality of the information available to health care professionals in making decisions about patient care and in the communication between health care professionals during patient care. Good quality of documentation improves the quality of patient care” (p.300). Thus, by identifying a principal source of data support, and various policies and procedures established by users for promoting information quality, this research contributes to our growing understanding of this important aspect of EMR success and the role of support in ensuring it.

A unique finding from the FHO selected for this thesis (which had adopted an OSS EMR) was the process behind creating user documentation for creating e-forms. A technically adept family member of one of the FHO’s physicians connected with a more advanced user through the OSS EMR’s online community of users, gathered information on creating e-forms, and used this information to generate a document on creating e-forms. Despite this one-time effort to render the practice of building e-forms more accessible to users, time constraints and users’ lack of IT skills remained barriers to creating and updating e-forms. This finding is unique because:

a) In no other case did users report outsourcing responsibilities related to data support;

b) In no other case was an online community of users a significant source of support in general, and for sharing knowledge on creating e-forms in particular.

Participants from the FHO also described informal meetings/conversations between physicians and their respective administrative staff regarding data entry conventions. In contrast, FHTs from Case Study A had implemented a variety of practice-wide policies and procedures for ensuring the quality of information as described above. Participants from these FHTs also described using the EMR for monitoring/surveillance and preventive care purposes—a stage of implementation not yet fully realized in the FHO. Thus, these examples demonstrate a potential connection between clinics with practice-wide policies and procedures for ensuring data quality and their ability to use the EMR for health management and preventive care purposes. These links are depicted the schematic Figure 4 below.
In summary, we propose that informal support as a main source for ensuring data quality—in place of the generic description of “support services” offered by Lau et al., (2011)—may contribute to a better understanding of the factors that contribute to EMR success.

![Informal support procedures/ activities:](image)

- Adopting standard terminology
- Creating e-forms templates
- Quality assurance
- Committee meetings
- IM strategy

![EMR success categories:](image)

- Information Quality
  - Consistency
  -Completeness

![Patient care impact:](image)

- Monitoring/surveillance
  - Preventive care

*Figure 4.* Informal support, information quality and preventive care. (IM= Information management)

Alongside informal support, users also described links between formal support and system quality, which are discussed below.

### 6.2 Formal support, system quality, and the promise of open-source EMRs

Researchers in the health informatics community are beginning to explore the potential for open-source to improve the quality of EMR systems. These researchers hypothesize that wider scale scrutiny of an EMR system’s source code is likely to result in a more innovative product (Kantor et al., 2003). It is therefore a noteworthy observation that both propriety and open-source EMR users described their reliance on formal sources of support (i.e., their EMR vendor or service provider, respectively) for solving problems related to the quality of EMRs e.g., system bugs, usability issues, lack of interoperability, and poor information architecture; all of which have consequences for the use of the system (e.g., workflow and workload). It is possible that the OSS EMR users were unable to rely on their community of users due to the so-called “free rider effect” described by Prasad et al. (2005), where the majority of users assume that others will take responsibility for system upkeep. Moreover, many of these users also expressed
dissatisfaction with their vendor/service provider’s inability to solve such matters in a timely fashion. These findings challenge the “promise” of OSS in Medical Informatics—that lower development costs will enable OSS vendors and service providers to center their business models on end-user training and support (Kantor et al., 2003). These findings seem more in line with Morgan and Finnegans’ (2007), whose field study of 13 IS managers identified several drawbacks of OSS—namely the lack of support and accountability. According to the study’s participants, without the backing of a commercial firm, the quality of support services weakens, in part because there is no entity to hold responsible or accountable for problems with OSS products (Morgan & Finnegan, 2007). However, the OSS service provider in question may have been an exception and not necessarily representative of the majority.

As discussed in the literature review, user satisfaction is a widely employed measure of IS success (Bailey & Pearson, 1993; Delone and McLean, 1992; Gallager, 1974; Ives et al., 1983, Rivard & Huff, 1988, and Shaw et al., 2002). Likewise, the theoretical framework for this study “recognizes success as a process construct which must include both temporal and causal influences in determining IS success” (Delone & McLean, 1992, p.83). Within this model, it is possible to conceptualize the causal influences of formal support. For example, because EMRs had become integral to clinical operations, delays in repairs for system quality issues (e.g., interoperability, usability and software bugs) had consequences for users’ workflow (e.g., the ability to retrieve information efficiently), workload (e.g., scanning documents into the EMR), and patient safety (e.g., missing lab reports and erroneous vaccination and drug interaction alerts). Furthermore, users cited the importance of formal service providers who were knowledgeable (i.e., of clinical work, the EMR system, and how a specific clinic operates) and possessed good counselling/communication skills (i.e., their ability to understand individual support needs). These relationships are depicted in Figure 5.
Moreover, users of both systems cited the rapid market growth of vendors/service providers (e.g., personnel shortages, prioritizing larger clients, etc.) as the cause of delays in response time—a topic currently being explored by health informatics researchers, albeit from the vendor’s perspective (Shachak et al., unpublished). Once again, this finding challenges the assumption that the service quality of OSS products is superior to commercial ones (Kantor et al., 2003).

### 6.3 Implications

This research has practical implications for health care managers and policy makers. Beginning with health care managers, there are several ways in which they can improve information quality, which is needed for the provision of health management and preventive care services. For example, the development of practice-wide tools, policies and procedures or an “information management strategy” for promoting data consistency and completeness can facilitate analytics, clinical decision-making, and communication. Furthermore, since it was so important in all cases, clinics should develop an in-house support strategy; for example, hiring a local technician to provide infrastructure support (at least on an on-call basis), training super-users, and clearly defining their roles and responsibilities.

As EMR adoption rates increase in Canada, a growing number of health care professionals, the clinics they work in, and the patients they serve stand to benefit from these systems. Findings
from this study suggest that the kind of support provided by vendors can play a key role in successful EMR implementations. Currently, however, government agencies responsible for certifying EMRs such as Ontario MD provide only minimal requirements in terms of support. For example, the mandatory support requirements (some of which are quite vague) are:

- EMR Vendor is able to troubleshoot common technical/user issues via electronic/remote support;
- EMR Vendor is able to remotely provide simple upgrades and code corrections;
- EMR User documentation is available in electronic format;
- Offers EMR training on all baseline functionality (Ontario MD, 2011, p.63-64).

These requirements fail to address some of the themes related to formal support raised in this study, which due to their implications for users’ workload and satisfaction, clinics’ work processes and patient safety, ought to be included in the support requirements for EMR certification.

6.4 Limitations and Future Research

This study has uncovered some promising findings concerning end-user support sources, characteristics, activities and EMR success in Ontario primary care; however, only 7 users of a single OSS EMR were interviewed for this thesis, which limits the tenability of certain claims and generalizations. For example, although findings from this study draw scepticism to the promise of OSS EMRs, the generalizability of these finding requires further investigation. In the same vein, although main findings from this thesis and Case Study A coincide, further research is needed to validate certain claims (e.g., the role of informal support in relation to information quality, health management and preventive medicine and; the role of formal support in relation to system quality, individual impact, and patient safety).

Another finding warranting further investigation is the connection between models of primary care, informal support and information quality. In contrast to the FHTs examined for Case Study A, the FHO selected for this thesis had not developed practice-wide policies and procedures for promoting the quality of information. This difference may be caused by the more inter-professional and collaborative nature of FHTs, however the relationship between models of primary care and practices that ensure data quality requires more research.
In summary, perhaps the most promising findings from this study are: the importance of on-site support; the impact informal support on information quality; and the ability of formal support to mitigate issues of system quality. These impacts, which were described by interviewees from Case Study A and this thesis, demonstrate the important role of end-user support in relation to EMR success. Thus, further investigating these impacts can make a significant contribution to our theoretical understanding of end-user support and its links to EMR success. The models proposed in the discussion can serve as the basis for a larger-scale, quantitative study of these relationships. To this end, items and constructs need to be developed, validated, and used in a provincial or even national survey.
7 Conclusion

In order to provide a better understanding of end-user support for primary care EMRs, we explored three research questions:

1) In what ways does post adoption end-user support affect EMR success for an open-source system adopted in a semi-rural Family Health Organization?

2) What are the differences between formal and informal sources of impersonal support—both for the OSS EMR investigated for this critical case study and the proprietary EMR used in Case Study A?

3) What are the commonalities and differences in the ways end-user support affects EMR success for the open-source EMR used in this critical case study and the proprietary EMR used in Case Study A?

For the first question, we found that informal support was highly important for standardizing clinical information and ensuring data consistency, which in turn enabled information retrieval (e.g., performing practice wide searches and producing reports) for preventive care purposes and monitoring of patients with chronic conditions. Thus, EMR adopters need to develop practice-wide information management strategies to ensure that these potential benefits of the EMR are realized. Furthermore, since formal technical support played a key role in mitigating the negative impacts of system quality issues on patient safety, the quality of formal support services (i.e., responsiveness and knowledge of support staff) should be clarified and included as requirements for EMR certification and funding.

For the second research question, user generated documentation better fit the principles of Minimalism than formal documentation. It is important for users to allocate resources to the development of internal help documents as part of their EMR implementation strategy. Vendors can help by working with users on adapting user manuals to their needs. Sharing documents through an online community can reduce the amount of resources needed for developing tutorials and manuals, which is an advantage of OSS EMRs.
For the third research question, many similar issues were identified between cases, which were independent of the setting (FHO or FHT) and system (proprietary or OSS). For example, both propriety and OSS EMR users described their reliance on formal sources of support for technical problem solving; however, users of both systems expressed dissatisfaction with their vendor/service provider’s ability to solve such matters in a timely fashion. Interviewees from both studies attributed this to the rapid commercial expansion of their formal EMR support providers (i.e., they could not hire and train enough support staff to meet the needs of users), which challenges the so-called “promise” of OSS in Medical Informatics. Furthermore, the synthesis of findings from both case studies highlighted the importance of on-site support and the impacts of informal and formal support on information and system quality, respectively.

This research contributes to our theoretical understanding of end-user support and its impact on EMR success in primary care settings. Themes identified in this study may provide some guidelines for new adopters, vendors, service providers, and agencies involved in EMR implementation on how to better support users and help them realize the potential benefits of the software. For example, new adopters should develop an information management strategy early-on during the implementation process to ensure the quality of information. This will facilitate practice-wide searches for specific groups of patients for preventive care purposes and managing chronic conditions. Findings from this study also provide vendors and service providers with insights into the needs of their clients; addressing these needs can help to build and maintain client or user satisfaction. As EMR adoption rates increase in Canada and their impacts become more widely felt by health care professionals and patients (some of which are tied to end-user support), agencies responsible for promoting and overseeing their implementing can further appreciate why effective end-user support should be made a priority for EMR certification and funding. We propose that such translations of the findings from this study can make a positive contribution to the implementation of primary care EMRs.
8 References


NAHIT (2008). *Report to the Office of the National Coordinator for Health Information Technology on defining key health information technology terms.* Retrieved from http://healthit.hhs.gov/portal/server.pt/gateway/PTARGS_0_10741_848133_0_0_18/


Appendices
Appendix A: Interview Protocol

Key informant interview protocol

CONFIDENTIAL

Key informant unique identifier information:

Key informant unique identifier: _________________________________
Key informant name: _________________________________
Date: ________________ Time: ________________
Location of interview: ________________
Interview recorded: Yes No
Recording folder/file number: _________________________________

Case:

This page is to be detached from remaining pages and added to key informant unique
identifier master list
CONFIDENTIAL
Preamable:

- We are conducting a study on the role of end-user support in EHR implementation in primary care with clinician, support personnel and implementation leaders at several FHT/Family Medicine programs.
- This study is funded by the Canadian Institutes of Health Research and involves researchers from UofT in collaboration with OntarioMD. The principal investigator is Dr. Aviv Shachak.
- To improve the accuracy of my notes and to facilitate follow-up work, analysis and overall quality of this work, I would like to record this interview. **Is it acceptable to you?**
- I will still take notes during the interview.

Nature of Participation in the Interview

- I would like to reiterate that participation in this study is completely voluntary and that you may choose to withdraw at any time or choose not to answer any questions.
- All information exchanged in this interview will remain confidential, reported only at aggregate level as indicated on the informed consent form, which you have signed.

Interview format

- Semi-structured interview mostly open-ended but also some specific questions.
- The interview will focus on your perception of the support needs for using EHR, support activities and characteristics and the way they affect the quality of the EHR, its use, user satisfaction and impact on practice.
A. Personal background

1. Age

☐ Less than 30  ☐ 40 to 49  ☐ 60 and over
☐ 30 to 39  ☐ 50 to 59

2. Gender

☐ Male  ☐ Female

3. Please describe your role and responsibilities (probes: how long have you been in this position, what is your professional/educational background)

4. How long have you been using EHR/ supporting EHR users/ involved in implementation of EHR?

B. Support needs, sources, attributes and characteristics

- We define support in a very broad sense that incorporates support from people, documents and other resources. It can be formal or informal and it includes a wide range of activities such as hardware and software maintenance, problem solving, consultation and training.

1. With this broad definition in mind, what can you tell me about the support for EMR?

2. From your experience, what are the main problems with EMR use in primary care? (probes: with hardware and software?, with data? using the various functions of the EHR? With learning to use it?). If no problems reported, ask about problems others may
3. How do you/ EHR users usually deal with these problems? (probes: do you turn to
documents?, other people?) Can you give examples?

4. What are, in your opinion, the most important characteristics of support people?

5. How do these characteristics help you/EHR users? (probes: can you give me an example)

C. EHR related attributes

1. Users only: What do you think of the quality of your EHR system? (probes: is it available
to you when you need it?, response time?, time saving? How does it affect
communication with other providers?)

2. How does support, as I broadly defined it, affect the quality of your/EHR system or the
data you collect? (probes: its availability, response time, time saving, interoperability?
Can you give an example?

3. What do the users you interact with think of the EHR (probes to perceptions of
usefulness, ease of use, etc; individual level impact such as workload, patient-doctor
communication, quality of care) ?

4. Are you/ they using it effectively and efficiently (probe to use of various functions?)
5. What would improve their/your use of EHR? (probe: how would support help?)

D. Impact on patients’ health

1. How does the (your) use of EHR influences patient outcomes and their health? (probe: can you give an example?)

2. What would improve the impact of EHR on (your) patients’ health?

E. Other Comments/Documents

1. Is there anything else you’d like to add?

2. What documents do you have that have been useful in helping you to plan for or use the system? Can you provide a copy to us?

Thank you for participating in this interview. As a token of appreciation for your valuable time and insights please accept this cheque.

☐ Cheque provided

☐ Cheque to be mailed
Appendix B: Coding Scheme

<table>
<thead>
<tr>
<th>Support Attribute</th>
<th>Code</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source</strong></td>
<td></td>
<td>These codes deal with characteristics of support for use of the EMR</td>
</tr>
<tr>
<td>Formal</td>
<td>Src Form</td>
<td>Support provided by an official source such as manuals created by the vendor, a help desk, or personnel from the vendor. Personnel from the FHT whose job includes at least some component of IT related duties are considered to be formal sources of support. Use this code to code negative comments (i.e., “support from outside agencies like the vendor and Ontario MD is lacking”) as well as positive comments.</td>
</tr>
<tr>
<td>Informal</td>
<td>Src Inf</td>
<td>Support provided from peers whose job is not IT related; can include a local champion or local expert user (e.g., “one of the other physicians in our group is very familiar with the EMR so he is able to help us with things like searches”). Manuals created internally by the FHT are considered informal sources.</td>
</tr>
<tr>
<td>Personal</td>
<td>Src Per</td>
<td>Support provided directly by a person either on site or by telephone. A help desk is an example of a formal/personal source of support.</td>
</tr>
<tr>
<td>Impersonal</td>
<td>Src Imp</td>
<td>Support provided by documents or websites. No direct contact with a person is involved.</td>
</tr>
<tr>
<td>On site</td>
<td>Src On</td>
<td>Refers to support provided on site regardless of who is providing it.</td>
</tr>
<tr>
<td>Off Site</td>
<td>Src Off</td>
<td>Refers to support provided from an offsite location.</td>
</tr>
<tr>
<td><strong>Support Activities</strong></td>
<td></td>
<td>Actions provided to help those using the EMR</td>
</tr>
<tr>
<td>Hardware Support</td>
<td>Act HS</td>
<td>Assistance or lack of assistance with the acquisition, maintenance, or use of hardware i.e. the computer, printers, etc.</td>
</tr>
<tr>
<td>Data Support</td>
<td>Act DS</td>
<td>Activities undertaken to ensure data is entered consistently and completely. This code is used to refer to activities related to data, not the quality of the data itself.</td>
</tr>
<tr>
<td>Functional Support</td>
<td>Act FS</td>
<td>Assistance provided (or not provided) to use or solve problems related to the PS program itself. Assistance with learning the various functions; i.e., how to do searches, how to make templates, short cuts etc. (E.g., “They come to me if they are having problems with the scheduler or problems with messaging.”)</td>
</tr>
<tr>
<td>Training and Education</td>
<td>Act T &amp; E</td>
<td>Refers to teaching users how to use the program initially when the organization is converting to an EHR and also the training that is required on an on-going basis when new staff are hired.</td>
</tr>
<tr>
<td>Project Management Support</td>
<td>Pr Mgt</td>
<td>Refers to the overall activities and efforts the organization must take in order to ensure the successful operation of the HER.</td>
</tr>
<tr>
<td>Support Characteristics</td>
<td>Describe the attributes of the support provided to users of the EMR</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Counseling Skills</td>
<td>Chr Coun Sk The ability of the person providing support to listen, to communicate patiently and in an empathetic manner, and with a willingness to try various alternatives. “ (E.g. patience and the ability to multi task and drop what I am doing to help someone who needs help are the most important factors)”</td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>Chr Know Includes technical knowledge and the ability of those providing the support to understand the problem being described and provide an appropriate answer.</td>
<td></td>
</tr>
<tr>
<td>Homophily/Heterophily</td>
<td>Chr Hom /Het Refers to comments that indicate there is, or is not, a gap between the technical knowledge the support person has and their understanding of the day to day work of the user. Must be used in the context of the support provided.(Eg The problem is the person that did it, I don’t think they ever did clinical work so they were OK at showing us the system but I don’t think they really understood how that applied to a patient.”)</td>
<td></td>
</tr>
<tr>
<td>Service Quality</td>
<td>Chr Serv Qual Comments related to the overall quality of the support provided including timeliness, responsiveness and accessibility (Eg “the service we get is very prompt” or “They usually have the problem fixed in an hour but an hour is a long time in a doctor’s office.”)</td>
<td></td>
</tr>
<tr>
<td>Business Model</td>
<td>Chr Bus Mod Refers to issues around the need to pay, and the amount of payment, required to obtain support from the vendor.</td>
<td></td>
</tr>
<tr>
<td>System Quality</td>
<td>This section refers to the characteristics of the EMR itself. Note if there are quality issues identified that do not fit into one of the attributes below, code as system quality (sys qual)</td>
<td></td>
</tr>
<tr>
<td>Availability</td>
<td>SQ-Avail Is the program and the computers that run it generally available to the user when needed; use this term to capture comments related to down time.( Eg It is improving all the time; when I first started it would go down a lot but it is better over time.”)</td>
<td></td>
</tr>
<tr>
<td>Response Time</td>
<td>SQ-Resp T Does the program and the computers respond quickly to commands or do the users find it slow; Eg “ For the most part it works well but sometimes it’s very slow and that’s very frustrating”</td>
<td></td>
</tr>
<tr>
<td>Interoperability</td>
<td>SQ-Int Op Comments related to the ability of the users of the EHR to communicate with other providers outside the FHT such as labs; pharmacies or hospitals who use different information systems</td>
<td></td>
</tr>
<tr>
<td>Information Quality</td>
<td>IQ-Comp Is the information that is in the EMR complete and accurate; is all patient data entered?</td>
<td></td>
</tr>
<tr>
<td>Consistency</td>
<td>IQ-Cons Is data entered in the same way, using the same terms and acronyms? Use this code for comments that include a garbage in/garbage out component.</td>
<td></td>
</tr>
<tr>
<td>Legibility</td>
<td>IQ-Leg Refers to the ease of reading information on the EHR.</td>
<td></td>
</tr>
<tr>
<td>System Usage</td>
<td>Describes the use of the EMR in the FHT or among the staff.</td>
<td></td>
</tr>
</tbody>
</table>
| Functions | Use- Func | What functions or features of the EMR are used or are particularly liked or disliked or that are most useful to particular categories of users; (“Eg we chart all information about the visit, the past medical history; all the labs”) Do not use this code for desired functions; an additional node has been established under desired functions which is now added to the usage node. Also use for comments about the extent to which or how much of the system capability is used or the efficiency of use (e.g. “people probably are using about 20 to 30 % of what this thing is capable of”)

Use for positive and negative comments about functions built into the system (eg “the system wants you to put in drug orders in a certain way such as 1 tablet for 30 days but then after 30 days the prescription will disappear and so you have to kind of look to see was the drug prescribed”)

Code functions/workflow when the function of the EMR causes a change to the way work is done;

If a function causes a problem to the user and you want to note that, then write an annotation(1)

| Desired Functions | Dsr Func | Use when the interviewee comments about attributes or functions that she/he wishes were available in the system

| Satisfaction | Comments related to how satisfied the interviewee is with the system and how they perceive the satisfaction of others.

| Overall satisfaction | Sat-Ovral | Use to code comments about the degree to which the interviewee is satisfied or not satisfied with the use of the EMR. (“I don’t have a lot of complaints about it-I really like it”) and also how the interviewee describes how other users like the system.

Use also to code comments they make about their satisfaction with specific features of the system; (Eg Its user friendly, I don’t have to be afraid of making mistakes”)

| Individual Impact |  |

| Workload | II-Wrkld | Use to describe any comments about the effect of the EMR on the amount of work required of the person being interviewed (e.g., “I don’t find it adds to the workload but it takes just as much time.”)

| Workflow | II-Wrkfl | Changes in work processes that occur as a result of the EMR; Use this code for comments about changes to the way a provider communicates with other providers and for comments that relate to the ability to access information quickly and easily, from remote sites, or by other providers. (Eg it’s a lot easier to find things-- to keep track of things”)

| Patient provider Communication | II-Pat Pr Com | Code comments related to communication between providers and their patients. (Eg you find you are not paying as much attention to them in terms of eye contact initially although I am getting better at that.”)

| Organization Impact | Refers to changes at the organizational level as a result of use of the EHR.

| Technical dependency | OI-Tech Dep | Use to code comments related to the inability of the
Coordinated Care  | Co Care | Refers to quotes that indicate how EMR use affects the process of communication among providers and facilitates coordination of care; e.g. *I think it puts everybody involved in the health care in a position to recognize that the information goes into a central place, to be coordinated, if the chips are down, by just one person whose job it is to pull all your health, all that information, and I think that’s a tremendous benefit to health care.*

| Patient Care Impact | PC-Prev | Use for comments on the impact of the EMR in patient care. |
| Monitoring and Surveillance | PC-Mon-Surv | Use to describe the use of the EHR for follow up on patients with chronic conditions, effect of treatments, or test results (HbA1c, Vit. D levels, blood pressures…) |
| Patient Education | PC-Educ | Used for comments related to use of EMR as an education tool for patients’ (E.g. “you can trend data to show patients, provide patients access to guidelines”). |
| Patient Safety | Pt Safe | Used to note the effect on patient safety that results from use of the EMR ie drug interaction alerts; |

| Emerging Themes | Themes that emerge from the data and do not fit with any of the other categories |
| Digital Island | Dig Is | Use to code comments related to the fact that users are operating in an electronic arena but working in a community where their colleagues are using paper systems. |
| Learning by trial and error | Tr -Er | Use to code comments related to the interviewees need or ability to learn the functions of the program on their own, on a trial and error basis. |

Additional themes that emerge from the data