Multimedia Features in Electronic Health Records: an analysis of vendor websites and physicians’ perceptions

by

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

Electronic health records (EHRs) facilitate storing, organizing, and sharing personal health information. The academic literature suggests that multimedia information (MM; image, audio, and video files) should be incorporated into EHRs.

We examined the acceptability of MM-enabled EHRs for Ontario-based software vendors and physicians, using a qualitative analysis of primary and acute care EHR vendor websites, and a survey of physician perceptions regarding MM features in EHRs.

Primary care EHR vendors provided more product-specific information than acute care vendors; however, neither group emphasized MM features in their EHRs. Physicians had slightly positive perceptions of image and video features, but not of audio features. None of the external factors studied predicted physicians’ intention to use MM.

Our findings suggest that neither vendors nor physicians are enthusiastic about implementing or using MM in EHRs, despite acknowledging potential benefits. Further research is needed to explore how to incorporate MM into EHR systems.
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Chapter 1: Introduction

1.1 Defining Electronic Health Records

The foundational task of clearly setting out what is meant by “electronic health record” (EHR) is a difficult one, and terminology is still evolving. A literature review by the National Alliance for Health Information Technology (NAHIT) in the United States found over sixty definitions of EHRs among industry stakeholders (NAHIT, 2008).

While a universally accepted definition of an EHR does not seem to exist, it is useful to adopt the classification set out in the NAHIT report. After dividing various types of records according to their structure and intended use, the term EHR is specifically used to describe “[a]n electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization.” (NAHIT, 2008, p.6)

Based on this definition, EHRs are expected to be interoperable repositories of patient data that exist within data management and decision support systems (NAHIT, 2008). This interoperability is more concretely described as electronic communication of patient charts within and between healthcare professionals (Brown, Grimm, & Shaw, 2007). It is this ability to communicate that separates an EHR from an electronic medical record (EMR) (Garets & Davis, 2006; NAHIT, 2008). The definition of an EHR also excludes patient-controlled electronic records, which are defined as personal health records (PHRs) and are generally viewed as complementary records that engage patients in managing their own information across multiple organizations (NAHIT, 2008). Additionally, EHRs are not intended to encompass digitized patient charts that consist entirely of scanned paper documents. Even though scanned documents can be transferred between providers in standard image formats, the functional scope of an EHR involves the ability to electronically exchange patient data and facilitate their analysis.

Even after eliminating EMRs, PHRs, and scanned paper charts, there is great diversity in the potential functions and content of EHRs. The concept of sharing information between
providers introduces the question of what types of information an EHR should contain. Text-based EHRs can hold large amounts of qualitative and quantitative data that can be programatically analyzed; however, the increasing use of digital diagnostic images presents the possibility of storing image files and other types of media as well.

1.2 EHR Functionality

EHR data do not exist in isolation; they are produced and maintained by complex information system software. Beyond basic data retrieval and entry functions, EHR systems are also expected to integrate clinical and patient-specific information (e.g. for drug interaction alerting and clinical decision support systems), manipulate data for reporting, and assist providers in providing best-practice care (Chaudhry, 2006; Fletcher, 2001; IOM, 2003). Therefore, it can be very useful to discuss EHRs using expected functionalities.

A joint report released by the Integrated Centre for Care Advancement through Research (iCARE), Canada Health Infoway, and the Canadian Patient Safety Initiative (CPSI) performed a literature search on EHRs using specific features as inclusion/exclusion criteria. Concepts incorporated into the search included electronic health record, computerized provider order entry (CPOE), computerized decision support systems (CDSS), medication administration/barcoding, and transition of care between providers (Brown et al., 2007).

Alternatively, eight essential capabilities of an EHR system were identified by the U.S.-based Institute of Medicine (IOM) in 2003:

1. Health information and data
2. Results management
3. Order entry/management
4. Decision support
5. Electronic communication and connectivity
6. Patient support
7. Administrative processes
8. Reporting and population health management
Each area was then decomposed into lists of sub-functions, which define the scope of broadly defined categories such as “health information and data” for system developers and non-clinical populations.

The detailed lists provided by the IOM reveal the expected future path of EHR development (from the perspective of 2003). Notably, there is a subsection under results management titled “Multimedia”, which includes images, waveforms, scanned patient consent documents, pictures, and sounds (IOM, 2003, p. 20). Including a multimedia section suggests that non-textual information can significantly enhance text-based EHR data, while implying that adequate transformation into text may not be feasible. There is also a tacit admission that integrating multimedia into EHRs is not a simple task, as the proposed timeline to implementation is listed as the middle and late phases of EHR development, which were estimated to be complete by 2011 (IOM, 2003).

The omission of items from the functional listing also provides insight into which capabilities are not considered essential to an EHR. For example, telehealth functions are not included in the IOM’s EHR report, and are specifically excluded in the joint iCARE/Infoway/CPSI report (Brown et al., 2007). Also, both reports deliberately disregard the technical infrastructure required for EHR implementation in favour of clinical requirements.

1.3 Potential Advantages of EHRs

Increasing specialization in medicine, combined with increasingly complex patient diagnoses and treatment courses, has resulted in networks of healthcare professionals caring for patients. The interoperability built into EHRs is intended to make complete and legible patient records available to all providers regardless of location or organizational affiliation, enhancing communication within heterogeneous healthcare teams. Storing structured patient data in EHR systems expedites billing and administrative procedures, such as providing discharge information to governmental regulatory bodies (IOM, 2003).

Improved care quality and coordination is possible with EHRs. Switching from paper to electronic charts can ensure that all previous treatments, prescriptions, and tests are recorded
and displayed for healthcare providers. This can help prevent treatment errors, such as accidentally triggering an allergic reaction, and conserve the resources needed to retest patients if lab results are misplaced or a different provider has already ordered tests (Canada Health Infoway, 2007). Evaluating metrics produced by the system can increase both physician and patient compliance with best practice care (Collins & Wagner, 2005; “Paperless”, 2009).

EHRs also lend themselves well to tasks that are not currently feasible with paper charts. The longitudinal course of chronic conditions can be tracked, providing a means to monitor individual patients or populations and intervene before a crisis occurs (Infoway, 2007; PCAST, 2010). EHR systems that generate automatic reminders for routine patient procedures, such as annual checkups, mammograms, and colonoscopies are another form of patient monitoring that can detect health issues early. Automatically screening new drug prescriptions for adverse effects and sending prescriptions directly to pharmacists, together with relevant patient data, can drastically reduce physician-pharmacist miscommunication, while enabling pharmacists to better address any concerns patients may have about their medications. EHR systems can even be connected to telemedicine technology, giving patients in remote communities consolidated records from data that may have geographically diverse origins (Infoway, 2007).

1.4 Current EHR Adoption Efforts

Although consensus on content and functionality has not been reached, EHR systems are being implemented around the world. Many of these efforts are the result of political pressure from national or regional governments, as EHRs are expected to improve patient care as well as streamline administrative and fiscal processes.

In 2009, the U.S. government introduced an economic recovery plan that included approximately $20 billion USD for the healthcare sector (athenahealth, 2009; McGee, 2009) through the Health Information Technology for Economic and Clinical Health (HITECH) Act (H. 1, 2009). The Act aims to encourage the development and adoption of IT in healthcare, particularly in the area of EHRs. Other associated systems, such as electronic...
drug prescription systems, are also part of the program. One of the goals of the HITECH Act is to computerize all American medical records by 2014 (Cole, 2009; The White House, 2009).

This move comes a decade after a landmark report from the IOM, which shocked legislators and the public with news of thousands of people dying annually due to preventable medical errors (IOM, 2000). The subsequent uproar paved the way for two follow-up reports in 2003, which advocated the integration of national medical data standards into EHRs and the wider healthcare infrastructure, improving patient safety and care (IOM 2003; IOM, 2004). Although this work was completed quite a few years ago, the use of EHRs in the United States is still lower than in other developed countries (Jha, Doolan, Grandt, Scott, & Bates, 2008).

Progress in the development of health information technology (IT) in Canada has followed a similar trajectory over time, with comparable EHR adoption rates (Jha et al., 2008) despite an earlier start on creating a national health infrastructure. Canada Health Infoway (Infoway), a national agency that disburses government funds to a variety of health IT projects across the country, was formed in 2001 and has invested over a billion dollars since then to develop a pan-Canadian EHR network (Infoway, 2007). Its aim is to provide all Canadians with EHRs by 2016.

Since Infoway is a funding body, not a national IT workgroup, provincial and territorial endeavours to develop and/or deploy EHR systems are more publicly visible. Late in 2009, the Ontario government agency responsible for EHR infrastructure made national news headlines with allegations of massive misspending and favouritism. The controversy led to a number of high-profile resignations and the provincial auditor general releasing a special report on the agency involved, eHealth Ontario. The report concluded that eHealth Ontario and its predecessor, Smart Systems for Health Agency, had made unwise financial and business decisions while spending $1 billion of the Ontario budget since 2002. Ultimately, the agency was criticized for failing to deliver useful health IT products (Office of the Auditor General of Ontario, 2009).
The story of eHealth Ontario, combined with ongoing news reports of American health care reforms, have brought much public attention to EHRs. Additionally, Canada and the U.S. are not alone in trying to digitize healthcare. EHR implementations are taking place worldwide, and in many other countries, significantly more progress has been achieved. A study of EHR adoption by general practitioners in seven countries places the U.S. and Canada significantly behind Australia, Germany, the Netherlands, New Zealand, and the United Kingdom (Jha et al., 2008). This same study found a significant lack of published data on hospital (secondary and tertiary care) EHR adoption, but used estimates to place adoption rates at less than ten percent for any country investigated. Other countries have had more success; Tjora & Scambler (2009) reported that all Norwegian hospitals use some form of EHR, although these systems are often run in parallel with pre-existing paper systems. Denmark and Spain (specifically the region of Andalucía) are currently implementing EHR-like systems by extending existing primary care and specialist EMR systems (Moller & Vosegaard, 2008; Protti, 2007), while Oman is considering the same strategy (Al Farsi & West, 2006).

1.5 Challenges of EHR Implementation

EHRs can be viewed as a central piece of a larger electronic healthcare infrastructure, where numerous components work together to improve patient care. In order to achieve the goal of interoperability in EHRs, patient data must be stored in standard formats and securely transmitted between providers. This data needs to be securely gathered, stored, and protected from tampering or unauthorized access; a range of software tools for analysis and knowledge dissemination is also required to effectively use the data (Office of the Auditor General of Ontario, 2009). Since the introduction of health IT in Canada has been based on voluntary adoption, a wide variety of paper and proprietary electronic systems are currently used to store patient data. For instance, a private practice could use digital administrative systems and paper charts concurrently. While the use of different media makes information sharing inconvenient, attempting to transfer information between two incompatible computer programs may be even more difficult and time-consuming. Importantly, this lack of interoperability reduces the scope of an EHR system to that of an EMR.
Software incompatibilities between EHR providers or vendors can be compounded by differing hardware requirements. Machines with digital outputs, such as monitors for heart rate or diagnostic laboratory equipment, are only able to transfer information directly to an EHR if both software and hardware connectivity is achieved.

While the technical obstacles to implementing EHRs are challenging, there are also social elements influencing the adoption of electronic systems. Maintaining the privacy of digital records is a concern (Griener, 2005). Academic, industry, and news publications have all reported on end-user resistance to computerized information systems in healthcare (Connolly, 2005; Lapointe & Rivard, 2005; Schumacher, Webb, & Johnson, 2009). Various levels of resistance to EHR systems have been recorded, ranging from full rejection (Connolly, 2005; Lapointe & Rivard, 2005) to using EHRs in parallel with pre-existing systems (Tjora & Scambler, 2009). This resistance could be due to a number of factors, including discomfort with entering data, perceived threats to personal autonomy, concerns about legal culpability, and substantial changes in workflow (Lapointe & Rivard, 2005; Lorenzi & Riley, 2004).

Some of this resistance to EHRs may be due to frustration with the current emphasis on structured data in the records. In order to facilitate computerized information retrieval and analysis, a controlled medical vocabulary is used throughout an EHR system. Although standard terminology arguably leads to objective charting that can be aggregated and analyzed at the population level, the lack of context and personal narrative can hinder communication between care providers. A structured data entry format appears to influence how clinicians gather and think about clinical information (Patel, Kushniruk, Yang, & Yale, 2000). Additionally, some evidence suggests that text-based EHRs do not capture the contextual and personal knowledge essential for informed decision-making (Hartswood, Procter, Rouncefield, & Slack, 2003).

1.6 Enhancing EHRs with Multimedia Information

The limitations of structured text, and the corresponding difficulties in communication, can potentially be overcome by storing non-textual types of data (multimedia) that are often not
captured in current systems. These new data can then be used on their own or in combination with existing patient information to enable analysis that would not have been possible with paper charts.

A basic example of a multimedia EHR (MMEHR) is the integration of digital image files and conventional text-based data. However, since diagnostic images are often available in paper charts, this particular subset of multimedia is not a true enhancement of electronic over paper records. Instead, MMEHRs incorporate data not currently captured, which can be used to better inform clinical judgement. This could include non-diagnostic images, other visual data, data with an audio component, or a combination of audio and visual information. These types of rich media (Daft, Lengel, & Trevino, 1987) can be used to store primary data alongside interpretations of those data, preserving the context of that interpretation and resulting in improved communication and decision-making. For example, a family doctor could attach a digital recording of a patient’s heartbeat to their record, allowing other members of the care team to listen to the same recording and come to a consensus regarding the patient’s treatment. The idea of expanding EHRs beyond text storage is not new. A 1997 report from the IOM envisioned a record containing “text, graphics, images, numerical data, sound, and full-motion video” (IOM, 1997, p. 104). This idea formed the basis of Lowe’s proposal for a multimedia electronic medical record system (Lowe, 1999). His focus was on the incorporation of images and physiological signals into text-based records, a non-trivial but feasible task using existing technology. A successful implementation of this type of system can be seen in the United States Department of Veterans Affairs (VA) healthcare system. The VA runs a hospital system for military personnel, making electrocardiograms and various diagnostic images available through their in-house EHR system (Fletcher et al., 2001).

No evidence of an operational MMEHR containing all of the media recommended by the IOM currently appears in academic literature. This may be due to the technical complexity of incorporating multimedia into EHRs, which further compounds the challenges of creating an EHR system. While tools such as voice recognition and natural language processing are rapidly improving, they may require more development before being deployed in clinical practice. There have also been concerns about the clinical utility of multimedia data (Mast,
Caruso, Gadd, & Lowe, 2001) and the legal consequences of acting on multimedia information, particularly if audio recordings are not considered legal documents.

However, multimedia can be viewed as a solution to some of the challenges associated with text-based EHRs. Enabling EHR users to store, retrieve, and analyze relevant contextual and narrative information can enhance clinical judgement and impact patient care. Resistance to using EHRs may also be reduced if the benefits of having multimedia data available are sufficiently clear.

Since any feature in a system is unhelpful if not adopted, the perceptions and attitudes of clinical users towards multimedia features should be assessed prior to implementation. This user-focused approach to enhancing EHRs can be used to develop useful new features that will improve the quality of health care provision (Shachak & Jadad, 2010).
Chapter 2: Literature Review

2.1 Introduction

To investigate the acceptance of multimedia features in EHRs, a clear understanding of the theoretical basis for the research is needed.

Since EHRs are information-intensive systems, it is appropriate to study them using information systems models. The theory of diffusion of innovations is widely used in studying both information systems and other types of innovations. Additionally, the technology acceptance model (TAM) is a popular theoretical framework applied in studies of user perceptions and adoption of IT, and comprises a parsimonious but powerful model for examining EHR acceptance. Concepts drawn from rich and synchronous media theories can also contribute to this investigation, as they propose potential explanations for unequal acceptance of technologies.

Finally, an overview of related studies is used to summarize previously published work on user perceptions and adoption of health IT based on these models, and identifies a lack of research in the area of MMEHR capabilities.

2.2 Information Systems and User Acceptance

Where large volumes of data are required to perform a task, an information management system can be used to maximize efficiency and minimize performance errors. These systems have many potential forms, ranging from mental schemas to paper forms in filing cabinets to computer databases. The general concept of an information system (IS) can be applied to nearly any task requiring the storage, retrieval, and manipulation of data.

All IS contain a framework for organizing information, as well as methods to store and access data. Additionally, IS require users to operate the systems, defining inputs and exploiting the system’s functionality to produce the desired output. User-centred system design has emerged from the recognition that IS are tools built to make users more
productive (Berg, Langenberg, v. d. Berg, & Kwakkernaat, 1998; Norman, 2002; Tjora & Scambler, 2009). Using this viewpoint, the success of an IS implementation is not only measured by the technical specifications of the system, but also how well it has been adopted and accepted by users.

This sociotechnical approach to IS design and deployment has been applied to health IT, and specifically to EHRs. Berg et al. (1998) presented design principles derived from the successful integration of an EHR system into an intensive care unit, emphasizing the need for direct end-user involvement in the design process, along with the ability of the system to facilitate work instead of adding new tasks. The authors also argued that the primary focus of an EHR should be to assist healthcare professionals in their daily work, and secondary usage of EHR data for administration or research should remain secondary in focus.

Tjora & Scambler (2009) are also proponents of this perspective. They examined the adoption of EHRs in Norwegian hospitals, finding that many EHR systems are run in parallel with specialized clinical systems instead of replacing them. The proposed cause for this partial adoption was the inflexible nature of the EHR systems, which did not match the highly collaborative and dynamic work performed by hospital staff. Stationary terminals could not adequately serve mobile workflow patterns, and decision-making through informal communication was difficult and time-consuming to document. The heavy use of specialized clinical systems implied that there were no inherent user issues with adopting technology, leading the authors to conclude that “it is not necessarily the most high-tech, multi-purpose computer-based solutions that promote the most effective practices … we need to include the staff as a kind of ‘connecting tissue’ that holds the hardware and the technological system together” (Tjora & Scambler, 2009, p. 523).

Cases where users resist adopting an IS have highlighted the importance of user acceptance. A classic example of failed IS implementation comes from the highly regarded Cedars-Sinai Medical Center in Los Angeles, California. Administrators at the non-profit hospital rolled out a $34 million system in 2002, but were forced to revert back to paper within a few months due to staff outrage (Connolly, 2005). Analysis of the situation revealed that there were technical difficulties with the software, but the bulk of resistance was a result of major
changes in clinical workflow patterns. Deficiencies in user training compounded the difficulty of adjusting to the new system, and physicians refused to take on new, time-consuming tasks like filling out comprehensive patient data forms and overriding irrelevant system alerts. Three years later, Cedars-Sinai had no immediate plans to roll out another system, but was instead relying on additional staff to maintain records and screen for errors (Connolly, 2005).

Research models, such as diffusion of innovation theory and TAM, are intended to help minimize IS rejection by identifying factors that can affect end user acceptance.

2.3 Diffusion of Innovations

The introduction of EHR systems into clinical workflow can be viewed as a conceptual shift that affects both procedures and the tools used to perform them. Researchers can study the progression of this shift using Rogers’ theory of diffusion of innovations (Rogers, 2003). This diffusion theory was based on individual and population-level technology adoption patterns observed in farming communities. By distilling these patterns into a behavioural model based on the properties of an innovation, communication channels, and characteristics of the social system, Rogers hoped to predict and potentially influence the spread of new ideas, practices, and tools within a population.

Diffusion is described as the communication process between members of a social system concerning a new idea. Over time, this can result in behavioural changes at both the individual and system levels. When the number of individuals adopting an innovation is plotted cumulatively against time, an S-shaped curve is seen, revealing a normal distribution of adopters. Rogers (2003) separated this population into five “adopter categories”, based on the relative time of adoption. The individuals in the population who adopt an innovation the earliest are labelled the “Innovators”, followed by the “Early Adopters”, “Early Majority”, “Late Majority”, and finally “Laggards”.

An individual’s adopter category is influenced by their transition through different stages in the innovation-decision process (Rogers, 2003). There are five stages within the innovation-
decision process: knowledge, persuasion, decision, implementation, and confirmation (Figure 1).

**Figure 1.** The innovation-decision process. Figure adapted from Rogers, 2003, p. 170.

These stages generally progress linearly. The knowledge stage marks an individual’s discovery of an innovation’s existence. This is followed by a persuasion stage, in which the individual forms perceptions of and attitudes towards the innovation. The decision stage is marked by the conscious choice to adopt or reject the innovation. Implementation of this choice, usually marked by behavioural change in the case of adoption, then takes place. A final confirmation stage allows the individual to reflect on whether his or her decision was correct, with the opportunity to reverse it if needed.

This model encourages researchers to focus on studying various attributes of people (see Adopter Characteristics in Figure 1), examining individual-level variables that could affect a person’s progress from knowledge through confirmation. These could include characteristics such as age, gender, profession, socio-economic status, and interpersonal relationships. By correlating personal characteristics with adopter categories and stages in the innovation-decision process, researchers can explore methods to identify potential adopters or rejecters and influence their decisions.

An alternative perspective of adoption provided by the model is a focus on the properties of the innovation itself. These properties are evaluated by individuals and so become
subjectively perceived attributes. Perceived attributes of innovations are studied as part of the persuasion stage, and generally include five variables: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003). Relative advantage is used to describe the improvement that adopting an innovation creates (such as increasing profit, decreasing errors, etc.), and can refer to any sort of consequence that an individual deems important. An innovation possessing greater relative advantage will be perceived to be useful to adopt. Compatibility refers to the fit of an innovation with an individual’s existing lifestyle and value system. Innovations that can transition easily into a user’s life will be simple for individuals to adopt. The third variable, complexity, refers to the level of difficulty that individuals have in understanding and using an innovation. Highly complex innovations often require technical and specialized knowledge to be used, which can create a barrier to adoption. Trialability is the ability for an individual to test an innovation (or give it a trial run) before making a final decision about whether or not to adopt it. In some cases, the personal experiences of others can serve as trials by proxy, and in others, trials can allow individuals to reinvent an innovation to address personal circumstances. Finally, observability refers to the extent that other individuals within a social system can see the effects of one individual’s adoption of an innovation. Easily identifiable results allow other individuals to view an implementation and identify a source of information about the innovation. Based on this view, modifying the innovation and its user interactions can also affect adoption. Moore & Benbasat (1991) used diffusion of innovations to create the Perceived Characteristics of Innovating (PCI) instrument for studying technology acceptance, which is less parsimonious than TAM but explains more variance in intention to adopt (Plouffe, Hulland, & Vandenbosch, 2001).

2.3.1 Criticisms of Diffusion Theory

One difficulty in studying innovations is that a researcher may view their work with a pro-innovation bias. This refers to the researcher’s perspective of studying a particular innovation in order to encourage its adoption by all members of the target population. Due to this bias, the researcher is convinced that the innovation is an improvement over the current situation, and so focuses on maximizing the number of adopters. Individuals who complete the
innovation-decision process and choose not to adopt the innovation do not have a separate adopter category, so are left out of discussions on diffusion that use adoption categories. Rice & Katz (2003) referred to this population as “dropouts” in their work on people who discontinued using Internet or mobile phone services. Studying the deliberate rejection of an innovation can suggest cultural or technical modifications for addressing individuals’ concerns; an innovation adopted in one situation may not be suitable for another. This lack of theoretical support for concepts such as rational rejection and reinvention is a limitation of diffusion theory (Rogers, 2003).

Additionally, the criteria for categorizing adopters is only based on whether or not they have adopted an innovation or the relative time of adoption, and does not probe their reasons for doing so. Therefore, a single category of adopters may actually comprise many groups of individuals with different motivations for adopting at a particular point in time. A model categorizing the population based on reasons for adopting may provide a closer link between perceptions and behaviour.

Rogers (2003) points out that the pro-innovation bias has resulted in a skewing of research topics away from “bad” innovations and methods to either discourage adoption or encourage rejection. Although diffusion theory is general enough to encompass innovations with both positive and negative effects, innovations studied are often highly technological objects with expected benefits for adopters, such as pharmaceuticals (Katz, Menzel, & Coleman in Rogers, 2003) or Internet access. While it may arguably be unethical to purposefully introduce innovations with no intended benefit, researchers could learn a great deal from observing popular innovations that demonstrate little or no benefit.

Another important criticism of diffusion theory is that it is a dominant research framework, having been referenced in hundreds of publications (Rogers, 2003). Although its visibility implies that the theory has been critically examined, there is a risk of propagating the weaknesses of the model across a wide range of disciplines. It is important for researchers to carefully evaluate the theory and its suitability for each proposed study.
2.4 The Technology Acceptance Model

The important role of users in ensuring IS adoption has led to the development of user acceptance as a field of IS research. Here, user acceptance is defined as an individual’s use or non-use of a system within an organizational setting. This is distinct from organizational adoption, which refers to an organization choosing to implement a system and mandating its use by employees (Cooper & Zmud, 1990). Investigators attempt to elucidate the causes and mechanisms affecting user acceptance of or resistance to systems, hoping that this information will explain these phenomena and assist in developing guidelines for improving user acceptance.

A popular research framework for studying user IS acceptance behaviour is the technology acceptance model, or TAM. Identifying a lack of theoretically rigorous measures to study user acceptance, this model emerged from the more general Theory of Reasoned Action (TRA) and attempted to relate end users’ perceptions to their adoption of computer systems (Davis, 1989). TAM postulates that technology usage or acceptance is based on behavioural intention (I), which is itself based on two sets of factors, perceived usefulness (PU) and perceived ease of use (PEOU). These perceptions can be influenced by external environmental variables, which are not formally investigated in the model. Personal attitudes towards the system (A) were originally included as an intermediary construct between I and PU/PEOU, but were eventually excluded due to insufficient justification (Davis & Venkatesh, 1996). Figure 2 demonstrates the relationships between the variables.
Figure 2. The Technology Acceptance Model (TAM). Attitude (A) excluded from later versions of TAM. Figure adapted from Davis, Bagozzi, & Warshaw, 1989.

The two sets of perceptions, PU and PEOU, are constructs that emphasize the importance of internal beliefs in affecting external behaviours. PEOU is defined as the assessment that interacting with the proposed technology or system is reasonably effortless. Conversely, PU refers to the functional utility of the system and its ability to assist users in completing tasks. PU was originally designed with job performance in mind, and so is measured in terms of work enhancement (Davis, 1989). It has been empirically shown to account for roughly half of the variance seen in I (e.g., Davis, Bagozzi, & Warshaw, 1989; Davis & Venkatesh, 1996), while PEOU exerts weak effects on I and PU (Davis, 1989; Venkatesh & Morris, 2000). In fact, some statistical analyses propose an argument for removing the direct effect of PEOU, leaving only its indirect effect through PU (Davis, 1989).

This observation emphasizes the importance of system functionality, even though designers may often focus on usability. Davis (1989) pointed out that users may tolerate poorly designed systems in order to access critical information, but a well-designed interface is not sufficient compensation for a system that does not perform useful functions. Additionally, by basing acceptance on an individual’s perceptions, objective measures of actual system usability or usefulness are not required. TAM can thus be used to examine user acceptance of IS that do not offer significant performance gains, or rejection of IS that can substantially improve work productivity. This perception-based model can also be used to gauge acceptance of a potential IS by employing I as a proxy measure for actual system adoption.
2.4.1 Using TAM in Research

Studying acceptance by using TAM requires the operationalization of PU and PEOU. Davis (1989) achieved this by creating scaled questionnaire items that elicited user perceptions of the usefulness and usability of a specific system, and testing these items across different user groups and systems for high reliability and validity. The PU and PEOU scales both show very strong reliability and construct validity. This work was later replicated by Adams et al. (Adams, Nelson, & Todd, 1992), further increasing its credibility as a theoretically and practically relevant research framework. Over the years, TAM has been empirically validated through meta-analysis of a diverse collection of TAM studies (King & He, 2006; Ma & Liu, 2004), differing in types of users and types of systems tested.

Even though TAM has been applied in many domains, the questionnaire scales used to determine PU and PEOU have remained constant. Often, researchers will insert the name of the system under study into the original questionnaire and deploy it (e.g. Chau & Hu, 2002). This approach allows researchers to use the scales without needing to revalidate them, and also ensures that all of the TAM studies are investigating the same construct. A meta-analysis of TAM recommended dropping PEOU from the model if forced to choose between measuring PU and PEOU, since the PU relationship is direct and well-supported (King & He, 2006).

Since TAM surveys often measure PU and I at the same time, there is a risk of biased results known as common method bias (CMB). This type of bias is due to measuring responses for different variables from the same person or collection period. CMB is recognized as a potential problem in IS research, although the extent and seriousness of the bias is disputed (see Malhotra, Kim, & Patil, 2006, and Straub & Burton-Jones, 2007 for opposing views). Within TAM studies, enough variance in I could be explained by CMB instead of PU to make formerly significant PU-I relationships insignificant (Sharma, Yetton, & Crawford, 2009). Researchers have developed methods to identify CMB (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Schwarz, Schwarz, & Rizzuto, 2008), although designing research studies to avoid CMB is preferred.
2.4.2 The Unified Theory of Acceptance and Use of Technology

Part of the appeal of TAM is derived from its ability to explain a large degree of variance in user behaviour using a small number of variables. Another popular acceptance model is the Unified Theory of Acceptance and Use of Technology (UTAUT), proposed by Venkatesh, Morris, Davis, & Davis (2003). UTAUT was developed by examining a number of existing models (including TAM and its predecessor, TRA) for commonalities and then combining them in a comprehensive acceptance model. One significant difference between UTAUT and TAM is that UTAUT incorporates many additional variables such as social influence and user age into the model. The inclusion of these variables increases the predictive ability of the model, but also increases the amount of data collection required to predict user acceptance, and the time it takes participants to fill in UTAUT surveys. Measuring broadly defined concepts such as social influence requires more user involvement than collecting demographic characteristics such as age and gender. Depending on the user-system combination being studied and the data collection protocol, the benefits of improving predictability may be outweighed by the cost of resources required to gather data for more variables and potentially lower response rates due to the length of the survey (Jepson, Asch, Hershey, & Ubel, 2005; Sahlqvist et al., 2011).

2.4.3 Extending TAM

Many of the external variables included in UTAUT have been previously explored in the context of TAM, although this has not resulted in changes to the model. One exception is the development of TAM2, which includes social and cognitive factors (Venkatesh & Davis, 2000); however, this model does not seem to possess the same popularity as its predecessor in the literature. The original TAM consciously excluded constructs relating to social norms due to concerns about the strength of the psychometric scales used and the highly individual nature of the personal computing programs under study (Davis et al., 1989). After testing TAM2 in multiple environments and at various time points, Venkatesh & Davis concluded that its subjective norm construct has a significant direct effect on mandatory systems, and this effect decreases as users gain experience with the system (2000). Therefore, including
social norm as a construct in TAM would focus the model on settings where use is mandated, while reducing its effectiveness in studying systems that can be voluntarily adopted or rejected.

Other external variables have been proposed as antecedents of PU and PEOU in a haphazard approach to refining the model (Moore & Benbasat, 1991; Yarbrough & Smith, 2007), though formal revision of TAM does not seem to have occurred. Gender has been suggested to affect PU and PEOU, attached to the assumption that these effects are induced by cultural attitudes towards technology and communication, and are not intrinsic (Gefen & Straub, 1997; Venkatesh & Morris, 2000). Other studies have found no significant gender effects on system adoption behaviour and attitudes (Dansky, Gamm, Vaseym & Barsukiewicz, 1999; O’Connell, Cho, Shah, Brown, & Shiffman, 2004). Age does not seem to predict adoption (Ernstmann et al., 2009; Schectman, Scholing, Nadkami, & Voss, 2005), despite the “digital generation” correlation between increasing age and reticence towards embracing new technology, seen in work on “digital natives” (Prensky, 2001) and the “net generation” (Tapscott, 1997). However, some researchers have suggested a relationship between general computing expertise and the willingness to adopt new systems (Dansky et al., 1999; Ernstmann et al., 2009). Expertise, unlike most external variables, is not predictable over time and can be voluntarily gained or lost.

Adding antecedents to TAM can assist researchers looking for ways to influence users’ behaviour (Venkatesh, 2000; Venkatesh & Davis, 1996). For example, dynamic external variables like expertise can be exploited (such as through user training) to encourage end user acceptance. Previous research on TAM antecedents affecting perceptions towards MM could not be located.

2.5 Media Theories

A complementary set of frameworks for studying user acceptance of multimedia EHR systems are media theories. These theories examine the effects of different media on the process of communication, based on the quality and quantity of information that a medium can transmit. EHRs are inherently digital communication tools, and are progressing from
containing text and still images to incorporating advanced multimedia such as digital audio and video files (Fletcher et al., 2001). The inclusion of specific media types could affect a system’s perceived usefulness and ease of use, and media theory can be used to isolate the effects of different types of multimedia on user behaviour.

One of the most popular media theories is Media Richness Theory (MRT). While examining the low uptake of various multimedia by business managers and executives, Daft et al. (1987) categorized different modes of communication according to their “richness”, which refers to the quantity of relevant information and contextual cues that a medium transmits. Richness also includes the ability to exchange information rapidly and accurately, leading to effective communication.

MRT suggests that there is an optimal choice or set of choices of media for a communication task, dictated by the content and context of the message (Daft & Lengel, 1986). Highly ambiguous communication requires using rich media to avoid misunderstanding, while easily interpreted messages are better expressed with lean media. For example, standard messages are more suited to media with low richness, such as mass written communiqués, instead of rich media such as face-to-face meetings (Daft et al., 1987). Deliberately pairing media lacking a variety of cues (such as audio, graphical, or social) with messages that do not benefit from added context is an obvious application of MRT to management practice, intended to optimize communication processes. Conversely, using rich media for messages with high levels of ambiguity is expected to be the most effective method for clear communication.

MRT was originally proposed in the 1980s, prior to the invention and diffusion of many communication technologies now in common use. The study that was carried out to justify the development of the theory consciously excluded new types of media such as email, citing the lack of access to these technologies (Daft et al., 1987). A more recent theory that specifically addresses communication using electronic media is Media Synchronicity Theory (MST), which is intended as a new and more inclusive theory than MRT (Dennis, Fuller, & Valacich, 2008). The authors note that MRT has not provided a satisfactory framework for examining communication using computerized media. This may be due to the static
placement of a medium on a spectrum of richness, resulting in a categorization of facilitating one of four types of communication tasks (Daft & Lengel, 1986). Dennis et al. (2008) argue that this characterization is too broad to accurately conceptualize media that is constantly evolving.

In contrast, MST analyzes media by decomposing them into functions; for example, text-only instant messaging systems are considered distinct from instant messaging systems that incorporate text, images, and video. Additionally, MST provides a different perspective on message classification, examining not the ambiguity of a message, but whether the purpose of it is to convey information or converge upon shared meaning. Instead of matching task richness to media richness, MST proposes matching task synchronicity (defined as the need of the sender and receiver of a message to simultaneously collaborate) with the ability of the medium to facilitate synchronicity. MST is also more dynamic than MRT, positing that there is no single “best” medium for a given task, but that the optimal fit between media and task may be found by combining different functionalities over time.

While the transition from MRT to MST increases recognition of human ability to modify and even subvert a medium, it also increases the difficulty of applying media theory to real-world situations. MST states that all communication tasks consist of conveyance and convergence processes, but does not indicate how to determine the extent of each process in a given task. For example, Muhren, van den Eede, & van de Walle (2009) examined how individuals in humanitarian organizations communicate to gather information about crisis situations. The authors reasoned that information gathering is a conveyance process, as it increases individual understanding. Based on their data analysis, the authors concluded that information gathering may be better accomplished using high synchronicity media, which is the opposite of what MST expects. One potential explanation is that the particular situation (crisis response) emphasizes the context of personal contact (using high synchronicity media) over the actual content of the message. Alternatively, the authors of the study may have misclassified information gathering as a pure conveyance process. Without clear guidelines for categorizing tasks, it will be difficult to apply MST.
Chapter 3: Related Research

3.1 General Work on EHR Development and Adoption

Advocates for EHR systems have pushed for digitization of healthcare for many years. In 1999, Lowe described his vision for ubiquitous EHR systems that fully integrated textual and multimedia data from multiple databases in real time.

“In the early 21st century we will see the emergence of sophisticated multimedia EMR systems that will seamlessly integrate text, images, and physiologic signals into a coherent patient record. These systems will support digital multimedia conferencing and decision-support tools that use imaging data in addition to alphanumeric information.” (Lowe, 1999, pg. 150)

On a related note, one prominent theme in the EHR literature discusses EHR implementation strategies and challenges that may arise. Grimson (2001) provides a broad overview of technical concerns surrounding EHR system development, and the EHR’s potential if these challenges can be overcome. Similarly, Adler-Milstein and Bates (2010) identify obstacles to widespread health IT in the United States, and provide recommendations to facilitate its expansion. A recent commentary compiled currently available technologies to offer a pragmatic selection of potential EHR features designed for people-centred healthcare (Shachak & Jadad, 2010). Additional articles offer advice based on previous EHR implementations (Ovretveit, Scott, Rundall, Shortell, & Brømmels, 2007; Venkatraman, Bala, Venkatesh, & Bates, 2008), or targeted to particular clinical user populations (Clarke, Hartswood, Procter, & Rouncefield, 2001; Fetter, 2009; Mehta & Partin, 2007). Holbrook, Keshavjee, Troya, Pray, & Ford (2003) even offer a methodology for purchasing an EMR system. Closer to home, Nagle and Catford (2008) assessed the Canadian healthcare system through the lens of change management and identified critical aspects of successfully integrating EHRs into the workplace, such as adequate leadership and training resources. Other popular topics within the EHR literature include technical system descriptions and
models (e.g. Eichelberg, Aden, Riesmeier, Dogac, & Laleci, 2005; Katehakis, Sfakianakis, Kavlentakis, Anthoulakis, & Tskinakis, 2007), as well as secondary research (e.g. Gill & Chen, 2008).

### 3.1.1 Adoption Studies

The articles discussed above generally reflect a positive viewpoint (i.e. Rogers’ pro-innovation bias), looking forward to what is possible with EHR systems. However, studies evaluating the current extent of EHR adoption reveal that EHR systems are spreading much more slowly than expected or desired.

Adoption studies of general practitioners suggest that a number of European countries, along with Australia and New Zealand, have very high levels of EHR use (Jha et al., 2008; Protti, 2007). Conversely, an American study reported a 15% adoption rate (Gans, Kralewski, Hammons, & Dowd, 2005). Recent results from a national survey indicate that approximately 45% of Ontario physicians and 39% of Canadian physicians used electronic charting in 2010 (NPS, 2010). A survey of EHR adoption rates in seven industrial countries determined that there is no reliable data on hospital implementations (Jha et al., 2008) in any of the countries studied, including the USA and Canada; interviews with local experts suggested that the hospital EHR rate was under 10% in any nation. A 2008 survey of American hospitals agreed with this 10% figure, noting that of this percentage, only one in five EHR systems could be classified as “comprehensive” (24 functions in all major clinical units) instead of “basic” (10 functions in one major clinical unit; Jha et al., 2009). Even Japan, where the government has strongly promoted hospital EHR systems, reported an overall adoption rate around 10% in 2007 (Yasunaga, Imamura, Yamaki, & Endo, 2008).

### 3.1.2 Case Studies

Although the studies mentioned previously imply that Europe and primary care clinics have higher rates of EHR adoption (than North America and hospitals, respectively), this trend does not seem to be reflected in the case study literature. A wide variety of reports outline historical and ongoing EHR implementations at various institutions. Three prominent
systems reported are based in the USA: the VistA system from the federal Department of Veterans Affairs (Dayhoff, Kuzmak, Kirin, & Frank, 1999; Fletcher et al., 2001; Kuzmak & Dayhoff, 2001; Siegel & Riener, 2001), the hospital systems at the Kaiser Permanente health maintenance organization (Anderson, 2009; Collen, 1987; Ovretveit et al., 2007), and the PROMIS system developed at the University of Vermont (ASPH, 1997; Cook, 1978; Schultz, 1988). Many other case studies focus on successful American systems in both primary and acute care (e.g. Chaudhry et al., 2006; Collins & Wagner, 2005; Goedert, 2009; Kane, 2008). Interestingly, descriptions of systems in Europe and systems that were rejected seem to be rare, and studies of acute care systems are seen more often than primary care systems. This does not accurately reflect the statistics presented in the adoption studies, which suggest that these case studies represent unusual situations instead of the norm.

3.1.3 Theory-Based Studies

While case studies provide valuable lessons about user acceptance and rejection of EHR systems, theoretical frameworks are not commonly applied to interpret the cases in question. Most EHR literature seems to be non-theoretical, and the most commonly seen model is TAM or some version of it (MacKinnon & Wasserman, 2009). One instance of this is a recent study incorporating TAM to examine the effects of various factors on the attitudes of ambulatory care physicians towards EHRs (Morton & Wiedenbeck, 2009; Morton & Wiedenbeck, 2010). PU was found to significantly affect attitudes, as did physician involvement and autonomy.

When an evaluation of user acceptance is undertaken, one strategy is to measure user satisfaction as an indicator of acceptance. Researchers have incorporated DeLone & McLean’s model of IS success and TAM into instruments measuring satisfaction, then used them to determine levels of user acceptance (Otieno, Toyama, Asonuma, Kanai-Pak, & Naitoh, 2007; Palm, Colombet, Sicotte, & Degoulet, 2006). It is important to note that measuring user satisfaction must be done retrospectively; that is, after the system has been in use for some time. Satisfaction cannot be measured in a pre-implementation phase. However, user acceptance as defined by TAM is derived from perceptions and comprises a prospective view of the system (based on a short trial). While satisfaction is a convenient metric to
assess, it may not be an adequate measure of acceptance without being augmented with a pre-implementation component. For example, it might be useful in studying upgrades to an existing system by measuring satisfaction before and after implementation. This can help account for variation in satisfaction due to using the system over time (Bhattacherjee & Premkumar, 2004).

Another characteristic of EHR studies using TAM and other acceptance frameworks is that they do not always provide much detail about the system under study, beyond some basic descriptions of functionalities (such as integrated PACS or CPOE). For example, Likourezos et al. (2004) list the functions available in their system of interest, but Wiggins, Trimmer, Beachboard, Peterson, & Woodhouse (2009) and Ilie, van Slyke, Parikh, & Courtney (2009) do not describe the systems being evaluated.

To address the issue of trying to conduct studies combining different EHR systems, researchers can provide a minimum or general system definition, so that any physician using a qualifying system can participate in the study (as in Walter & Lopez, 2008). However, this strategy does not measure whether functional differences between systems affect user acceptance. Unique features, such as a graphical MRI colocalization tool (Puentes et al., 2008), could significantly influence user perceptions.

3.2 EHR Implementations Studied with Diffusion of Innovations

Adoption studies and case reports are helpful for painting a general picture of global, national, and organizational adoption trends. When studying individual users, a theoretical framework is useful for contextualizing results and building towards a picture of user adoption trends.

Rogers (2003) points out that diffusion of innovations theory has been used to study a variety of adoption trends in healthcare, notably in public health campaigns and prescription practices. Diffusion of innovations has also been applied to evidence-based clinical decision-making (Lemieux-Charles & Barnsley, 2004). The authors note that the adoption decision is
not necessarily a fully rational one; the presence of strong scientific evidence does not cause rapid or effective diffusion. For example, a study on the spread of tetracycline revealed that scientific evidence of the drug’s efficacy was not usually sufficient to lead to physicians prescribing it. Instead, the deciding factor seemed to be endorsement from colleagues who had already adopted tetracycline (Rogers, 2003). This underlines the importance of considering not only the relationship between an innovation’s attributes and characteristics of the adopter, but also taking into account the context of an adopter’s social environment (such as workplace, culture, and membership in various organizations) (Champagne & Lemieux-Charles, 2004).

This sociotechnical perspective on diffusion has been noted by Greenhalgh et al. in their studies of nationwide electronic patient record implementation in the UK (Greenhalgh et al., 2008; Greenhalgh et al., 2010). Having previously created a diffusion model combining existing theories (Greenhalgh et al., 2005), they interpreted the ongoing implementation process with an emphasis on interpersonal attributes (Greenhalgh et al., 2008). Within this interpretation, the authors found that users reported low compatibility with the highly complex system, despite acknowledging its relative advantage.

Bower also demonstrated the value of using diffusion of innovation theory in studying EHR adoption (2005). Using data from across the United States, he produced a diffusion plot remarkably similar to Rogers’ normal distribution of adopter categories and analyzed healthcare executive interviews using a variety of variables, including some of Rogers’ attributes of innovations. EHRs were found to have high relative advantage and complexity, as well as moderate compatibility. Trialability and observability were not assessed, as Bower did not find sufficient evidence of a consistent and significant effect (Tornatzky & Klein, 1982, as cited in Bower, 2005).

Rogers’ attributes of innovations are conventionally associated with the persuasion stage of the innovation-decision process (2003). While no research seems to exist that quantitatively measures changes in user perceptions of Rogers’ five attributes over the course of EHR implementation (e.g. through Moore & Benbasat’s PCI (1991)), some studies of other perceptions have been undertaken. Two studies of physician perceptions have indicated that
perceptions of saved time and quality of care do not change over the course of an implementation, even if measurable improvements occur (Pizziferri et al., 2005; van der Meijden, Tange, Troost, & Hasman, 2001). However, El-Kareh et al. (2009) reported an increase in positive physician perceptions of an EHR system over the first twelve months of implementation. The discrepancies between these studies warrant further research into whether user perceptions change over time.

None of these three studies of physician perceptions analyze their results within a theoretical framework. The choices of which perceptions to study are not explained, nor are the results embedded within a larger context. The use of a validated scale such as the Perceived Characteristics of Innovating (PCI) instrument, based on the attributes of innovations, would allow researchers to more rigorously investigate perceptions (Moore & Benbasat, 1991).

In contrast, Griever (2010) qualitatively analyzed primary care physician perceptions post-implementation using the attributes of innovations framework. High complexity and medium relative advantage were observed. The EHR system was not very compatible with pre-existing workflow, but highly compatible with physician values (e.g. patient safety, quality of care, etc.). These results agree with Bower’s findings, mentioned previously (2005), and indicate that perceptions of EHR attributes are similar between different populations.

Bower notes that most diffusion studies of healthcare innovations focus on describing past implementations, instead of prospectively studying diffusion (2005). Importantly, there seems to be an information gap in the innovation decision process prior to implementation. A study cited by Coye & Kell (2006) found that most hospitals relied on vendors and general consultants for guidance on purchasing technology; the use of specialized and impartial sources seemed to be minimal. This situation raises the question of whether EHR purchasers (physicians and/or executives) have adequate information to make informed decisions, and whether a lack of information could be a barrier to EHR diffusion.
3.3 EHR Implementations Studied with TAM

TAM has been studied extensively in many disciplines, and the relationships between theoretical constructs have been repeatedly confirmed (King & He, 2006; Ma & Liu, 2004). Within the health sector, studies of telemedicine (Chau & Hu, 2002; Hu, Chau, Liu Sheng, & Tam, 1999) and mobile monitoring for chronic conditions (Lin & Yang, 2009) have indicated that the typical relationships between PU, PEOU, and I hold true for health information technologies. The degree of variance of I explained by PU is consistently higher than that explained by PEOU (King & He, 2006), allowing PEOU to be omitted without seeing a large drop in TAM’s explanatory power. The relationship between I and actual technology use is strong, and so I is considered an acceptable proxy for usage (Davis et al., 1989). From a study design perspective, measuring intention instead of actual use allows TAM to be applied in a cross-sectional study (measuring PU, PEOU, and I at the same point in time) instead of a longitudinal one. Using I as a proxy also allows researchers to apply TAM to technology not yet implemented at the time of the study, permitting the study of system mock-ups and prototypes as a preliminary measure of future adoption (e.g., Ernstmann et al., 2009).

Some examples of TAM studies exist for health IT systems, such as administrative systems (Aggelidis & Chatzoglou, 2009), CPOE (Paré, Sicotte, & Jacques, 2006), and e-health cards (Ernstmann et al., 2009). Often, these studies will augment TAM with additional factors to explain additional variance in I. These factors may include constructs pulled from existing frameworks (e.g., Palm et al., 2006; Wiggins et al., 2009), or may be based on the researcher’s construct of interest, such as anxiety (Aggelidis & Chatzoglou, 2009; Dansky et al., 1999). These modifications provide valuable perspective on potentially relevant factors outside of TAM, but at the expense of some parsimony and perhaps construct validity, if the new model has not been revalidated. For example, Wiggins et al. (2009) added a measure of prior experience to the basic TAM framework in their study of physician acceptance of EMRs. As experience is a positive mediating factor of acceptance in UTAUT, the authors expected to find a positive correlation between EMR experience and intent to use EMR systems; however, no significant correlation was observed, although this may have been due to the study’s small sample size. Another study investigated an assortment of potential
factors affecting physician perceptions of PU for EMR systems, and determined that computer anxiety was the only relevant factor (Dansky et al., 1999). A third study found no significant relationships for a variety of factors, as discussed later (Morton & Wiedenbeck, 2009).

The inclusion of experience and similar factors is valued in acceptance research because they can be manipulated to influence user acceptance. TAM does not suggest methods for affecting I, but uncovering relationships between PU and potentially manipulable external factors can improve the applied relevance of the model. In the case of physicians’ acceptance of EHRs, computer experience and satisfaction seem to be the most commonly examined non-demographic factors potentially affecting PU and I (Yarbrough & Smith, 2007). Investigation of technology-specific factors, such as the number of EHR systems that a physician has used, was not found. Additionally, studies analyzing components or functions of a system individually were not seen in the literature. This is likely an effect of studying implementations of totally new systems, rather than upgrades or modifications to a previously adopted system.

3.4 Research Using Media Theories

Although media richness theory (MRT) has been a popular theory with managers and executives for many years (e.g., Stueart & Moran, 2007), researchers have been unable to find empirical support for MRT in multimedia (a number of examples are cited in Dennis et al., 2008). In response to this, media synchronicity theory (MST) has been developed to address the advances in communications technology that have occurred since MRT was first introduced. The authors of MST have proposed a model relating communication and media optimization that is empirically testable (Dennis et al., 2008). Studies validating the model and introducing relationship coefficients between the variables could not be located; this may be due to the relatively recent emergence of MST.

Research involving MST seems to be centred on collaborative work in corporate or educational settings (DeLuca & Valacich, 2006; Kienle, 2009). As online learning and distributed or virtualized organizations are becoming increasingly common, MST may be a
viable alternative to MRT (Dennis et al., 2008). Interestingly, MST does not seem to have been applied to any healthcare organization or team, even though improved communication between providers is a priority of health IT (Infoway, 2007). At present, the only example of MST explicitly applied to the health sector is found in the area of public health crisis management, where multiple types of technology and media are used to coordinate widespread responses to an emergency situation (Gomez & Passerini, 2007; Muhren et al., 2009). A popular incentive for healthcare providers to adopt EHRs is facilitated communication through transferring digital information. However, without evidence to inform the development of multimedia capabilities in health IT, the potential benefits of EHRs may be difficult to realize.

3.5 Studies Evaluating Website Content

The number of websites on any given topic is rapidly growing, and website content can change at any time, resulting in the Internet being a very volatile source of information (Bar-Ilan & Peritz, 2009). Websites can also move to different URLs, creating concern about using web references in research (Lawrence et al., 2001). However, the increasing prevalence of Internet links in journal articles indicates that valuable information can be found online (Lawrence et al., 2001). Researchers have also published hundreds of methods for evaluating various types of websites (Kim, Shaw, & Schneider, 2003; Law, Qi, & Buhalis, 2010; Park & Gretzel, 2007; Williams, Nicholas, Huntington, & McLean, 2002).

Website evaluation methodologies can take a librarianship perspective, focusing on establishing the authorship or credibility of the source, independently from the subject matter (Dalhousie University, n.d.; Raward, 2001). Alternatively, emphasis may be placed on the accuracy of factual information provided. Additionally, many evaluation methods are designed around a single subject domain or research question, which can make them difficult to adapt for other uses (Gagliardi & Jadad, 2002; Law et al., 2010).

Some research presents evaluation methodologies that are not based on a theoretical model (e.g., Akram, Thomson, Boyter, & Morton, 2008; Bean, 2011; Michalec, 2006). While custom criteria may be appropriate for certain specific research questions, theory-based
Methodologies have the potential to be generalized and applied across diverse websites and domains. For example, studies have been performed using TAM as the foundation for developing criteria to evaluate web portals (Eyono Obono, 2010; Yang, Cai, Zhou, & Zhou, 2005). TAM-like constructs were also used in a study of hotel websites (Jeong & Lambert, 2001); while the authors did not explicitly mention TAM, they did find significant PU-I, PEOU-I, and A-I relationships. While these examples illustrate the flexibility of a theoretically-based evaluation method, it must be noted that there is no consensus on how to operationalize TAM for websites. TAM also focuses on the user's experience using the website instead of the website's content itself. A general model based on objective versus subjective content elements, such as authorship information (objective) and layout (subjective), might be more useful for examining website information content independently of user experience.

3.6 Summary: Research Gaps and Study Purpose

Information systems need to meet user needs in order to be successfully adopted and integrated into the user environment. User perceptions of an IS can be studied using the diffusion of innovations framework, which combines attributes of an innovation with a sociotechnical view of the context it will be deployed in. This popular theory is known to have a pro-innovation bias, as it does not account for deliberate rejection of an innovation, and has been applied retrospectively with qualitative analysis or with unvalidated scales. However, it still offers a valuable framework for studying individual adoption behaviour over time.

TAM is a related model that uses perceptions to predict user acceptance behaviour of IS in organizational contexts. TAM is a popular IS model, as it is parsimonious and highly reliable across many types of technological innovations (including health information technology). The intention construct has been shown to be an acceptable proxy for actual system use, allowing researchers to investigate IS that are still under development. Efforts have been made to define external factors driving perceptions, but the results have been generally inconclusive.
The literature on EHRs has not applied any of these theoretical models extensively, focusing instead on implementation case studies and measuring the spread of EHR systems. Constructs used in research are often not grounded in theory or have not been validated. A pro-innovation bias is prevalent in the field, even without strong evidence of consistently positive effects. Part of this may be due to the extremely diverse nature of EHR systems, as little agreement exists on what features or functionality should be present.

One major function of EHR systems is to facilitate communication between health care providers, potentially through the use of non-textual multimedia (such as images, audio, and video). Appropriately integrating multimedia into EHRs can be supported by media theories such as MST; however, very little work has been carried out using MST to study any health technologies.

There have been a number of studies reporting single examples of multimedia integration into EHR and EMR systems, such as the development of a graphical MRI co-localization tool (Puentes et al., 2008) and work done by the VA to incorporate different types of diagnostic images into the VistA system (Kuzmak & Dayhoff, 2001). However, these reports focus on the technical challenges and successes faced by the developers, and discussion of user reaction is limited to preliminary or pilot results, if mentioned at all. This may be a reflection of multimedia features still being in early developmental stages, as support for basic textual records is likely prioritized over support for multimedia data. There is also the possibility that developers are providing features that end users find difficult to use or irrelevant to their practice.

This study intends to address a number of the research gaps discussed above by:

- using pre-validated theoretical models to study the readiness of physicians to adopt MMEHRs. An overview of the EHR diffusion literature revealed that few studies have been based on existing adoption or acceptance models (section 3.1). Additionally, it does not seem that any theoretically grounded studies of MMEHRs have been performed (section 3.4). No models seem to exist for evaluating website content either (section 3.5). Using rigorous models and methods in health research
will be valuable for advancing evidence-based decision making in all aspects of healthcare.

- conducting a prospective, exploratory study using both TAM and diffusion of innovations. Although both models investigate an individual’s decision making prior to using a system, they are often applied in retrospect (sections 3.2, 3.3). Some of the rationale for these studies may have been the difficulty of creating clinical systems that can be used on a trial basis. The current study focuses on potential upgrades to an existing EHR system without including embedded mockups, bypassing development and usability issues. By revalidating TAM for prospective studies without trials, a wider range of potential applications for TAM can be explored. Additionally, this provides cost-effective data for administration and IT staff to use in planning IT development.

- using the innovation-decision process to look for upstream barriers to diffusion, specifically the knowledge needed to form favourable perceptions of an innovation and then progress through the persuasion stage. The TAM perception constructs (PU and PEOU) are relevant to the second stage of the process, persuasion. Investigating TAM antecedents is useful for understanding factors affecting the second stage; however, it does not examine factors that could affect the first stage of the process, knowledge. Prior knowledge about an innovation’s capabilities could act as an upstream factor affecting later stages (persuasion and the following stage, decision). For example, EHR vendor websites could provide potential users with information that creates positive perceptions, which in turn encourages the decision to adopt the system.
Chapter 4: Research Questions

The purpose of this research was to examine the current acceptability of EHR systems with multimedia features to Ontario-based physicians and software vendors. The exploratory research query investigated whether physicians and vendors were interested in using and offering multimedia features, respectively, and the most acceptable types of features. A study design was developed that focused separately on commercial EHR vendors and physician users, using both qualitative and quantitative methods, and then integrated the results to create a comprehensive interpretation.

For vendors, the main research question was *What information do commercial EHR vendors provide about their products?* This was divided into three areas of interest: differences between primary and acute care system features, comparisons of online information supplied by vendors, and descriptions of product features and specifications (focusing on multimedia capabilities). Reviewing information provided by vendors showed the extent of their MMEHR capabilities, in addition to their general approach towards information dissemination. It also provided insight into how vendors portrayed themselves and what perceptions they attempted to influence through their website information.

The research question that pertained to physicians was *To what extent do external factors influence physicians’ perceived usefulness of, and intention to use MMEHRs?* This question investigated the relationship between external factors, such as demographic characteristics or prior experience using EHR systems, and user acceptability of multimedia functionality. Data drawn from this portion of the study were used to gauge the level of user readiness to accept EHRs with multimedia features.

The results of this preliminary work will provide a foundation for further study of MMEHR acceptance by vendors and physician users.
Chapter 5: Methodology

5.1 Study Design

In order to answer the above research questions, a concurrent triangulation study was designed. One part was a qualitative review of commercial EHR vendor websites (referred to as the “Vendor Website Analysis”) to assess publicly available information about their EHR products, with a particular focus on multimedia features. The other part of the study consisted of a cross-sectional survey (referred to as the “Physician Survey”) that used the TAM framework to gauge physicians’ attitudes towards MMEHRs. Respondents’ self-reported demographic characteristics were also collected and potential relationships between external factors and perceptions of MMEHRs were investigated. Comments from questionnaire participants were qualitatively analyzed, providing additional insight into participants’ perceptions.

The qualitative and quantitative data gathered from both parts of the study were used to answer the research questions, and synthesized to provide relevant contextual information for further research into MMEHRs.

5.2 Vendor Website Analysis

5.2.1 Data Sources

To collect data for this part of the study, a list of EHR vendor websites was compiled. Exclusion criteria were applied to ensure that all vendors currently offered an EHR system within Ontario. Vendors who appeared to offer an EMR system were also included in order to capture as many EHR systems as possible, whether or not they advertised interoperability with other systems. Vendor websites were then evaluated on the content and presentation of information about their systems, particularly in relation to multimedia. All data collection was limited to publicly available information.
Two main sources of data were used to find primary and acute care EHR vendors. The first source was OntarioMD (“EMR Advisor”, 2011), which publishes a listing of certified primary care EMR systems that meet Ontario’s provincial standards. To be certified by OntarioMD, systems must satisfy a number of data portability and interfacing requirements; these could be interpreted to meet the interoperability aspect of the EHR definition (OntarioMD, 2011a). Physicians wanting to implement one of these systems can apply for funding from the Ministry of Health and Long Term Care (MOHLTC). Along with the list of vendors, OntarioMD also provides vendor responses to a number of standard questions; this information was incorporated into the website analysis as well.

Acute care EHR vendors, along with additional non-certified primary care vendors, were identified using the ITAC (Information Technology Association of Canada) Health members list (“ITAC Health members”, 2011). This list contains contact information, website addresses, and profiles for information technology organizations that are active in the healthcare sector. ITAC Health, formerly known as the Canadian Healthcare Information Technology Trade Association (“CHITTA”, 2008), is an established national industry association, and so can be considered a reputable, consistent, and reasonably comprehensive source of information. Although ITAC Health does not categorize its members by products or services offered, a suitable alternative was not found. Other health information technology organizations such as Canada Health Infoway and eHealth Ontario did not appear to offer EHR vendor lists.

5.2.2 Vendor Inclusion Criteria

Starting with the full list of approximately 120 ITAC Health members, and 12 OntarioMD offerings, each organization was examined and categorized according to the criteria as detailed below to produce the final vendor list:

1) *Does the organization offer a software system related to electronic health or medical records?* This was determined by looking for a specific mention of EHRs or a description of a product that could correspond to an EHR or EMR. At this stage, vendors who provided hardware or support were not yet excluded. This criterion
excluded organizations that do not offer computer products, such as law firms and professional organizations.

2) *Is the system designed for primary or acute care organizations?* This was determined by examining the target client population for the system. There are many systems that can be labelled “electronic health records”, ranging from personal or consumer health records to tertiary care documentation. This criterion removed personal and community health record systems from the final list, and also separated primary care systems from acute care ones.

3) *Does the system maintain patient profiles and documentation for direct clinical use?* This is a very general definition of an EHR system. A standard definition such as that provided by NAHIT (see section 1.1) was not used, in order to include as many products as possible, and also because it is difficult to classify systems based only on website information instead of the actual product. This criterion excluded systems with administrative functions only (e.g., billing or scheduling), along with standalone picture archiving and communication systems (PACS) and computerized physician order entry (CPOE) systems. Notably, many of the products included here may be more accurately categorized as EMRs (missing the interoperability component of EHRs), but are still included in the analysis.

4) *Is the system currently available or implemented in Ontario?* Most vendors target their products towards specific jurisdictions in order to assure their clients that the systems will be compliant with the relevant regulations (such as privacy and reporting) of that area. This implies that systems implemented in one jurisdiction may not be suitable for another. To ensure that systems were not missed, search sensitivity was increased, accepting systems that did not specifically state where in Canada they were deployed.

5.2.3 **Data Collection and Analysis**

The final vendor list contained the names and website addresses of all vendors who offer a system that met all of the inclusion criteria. Nineteen vendors offering a total of 21 systems were included (see Figure 3).
Figure 3. Listing of EHR systems and vendor membership in ITAC Health and OntarioMD. Acute care systems (n = 5) are shown in the box; all other systems are for primary care (n = 16).

Each vendor website was examined for a number of general and system-specific characteristics. Website layout and content information was collected using printouts and screen captures. A general data collection template focusing on vendor information, website content, and EHR system features was also employed (see Appendix A). The data for each website and system were organized according to the three comparisons that were outlined in the research question above.

For each area of interest (differences between primary and acute care systems, properties of online information supplied by vendors, and descriptions of product features and specifications), the website data were coded and grouped into broadly recurring themes. Explicit information, such as text and graphics, was analyzed together with implicit information on topics such as currency and usability. A peer reviewer independently analyzed a randomly chosen subset of the websites (10 of 21) and provided feedback towards a unified coding scheme.
5.2.3.1 Comparison 1: Vendor Websites

The comparison of primary and acute care systems focused on differences in the comprehensiveness and persuasive aspects of EHR system information provided on vendor websites, and of the website as a whole. All 21 systems were considered.

Since a suitable analytic framework was not found, the categories used in the present evaluation were based on the content extracted from the websites (i.e., a grounded theory-like approach), and were also influenced by constructs designed by other researchers (Kantner, Shroyer, & Rosenbaum, 2002; Tsai, Chou, & Lai, 2010). This strategy highlighted trends in vendor website information content and delivery, and enabled an investigation of the differences between primary and acute care vendor websites.

The first part of the website evaluation focused on the comprehensiveness of the information about EHRs and the vendor’s particular system on the website. This refers to various types of information that may not specifically discuss system capabilities, but are still relevant to EHRs. Simply recording the volume of EHR-related content was not possible, due to the difficulties of trying to consistently measure the amount of online information on a single webpage or site. Therefore, comprehensiveness was outlined using categories that would be relevant to potential clients. These included:

- **Last date of update.** The frequency of website updates shows how current the information is, and can indicate the priority that the vendor places on keeping the website up to date. This date was drawn from the page footer copyright year on the EHR system homepage when more detailed information was not available.

- **External connections.** Being affiliated with or certified by reputable associations, partners, and suppliers can improve perceptions of vendor credibility and stability in the highly volatile environment of EHR systems.

- **Customer testimonials.** Indications of customer satisfaction could be useful in convincing potential customers to consider buying the product. The level of detail provided may also affect the credibility of the testimonial, where more detail seems more reliable.
- **Customer support services.** Vendor-provided resources such as documentation, technical support, and web portals are listed. Standard contact information for the vendor is also listed (i.e., phone, email, physical or mailing address, and, optionally, fax).

- **Topics addressed.** Vendors can present text that is not related to a specific feature, but is part of the larger discussion around EHRs. Examples include security concerns, cost savings or return on investment, and digitization of existing records. Topics must be the subject of at least one complete sentence to be considered a discussion – simply listing various subjects is not adequate.

- **Vendor’s use of non-textual information.** This category is intended to gauge the vendor’s own use of multimedia in presenting their system. The type of graphics used (such as stock images, figures or screenshots) and any use of audio, video, or animation were noted.

- **Online product demonstrations, or demos.** System previews can include images (such as screenshots) or walkthrough-style videos. These demos can give potential customers an indication of how a particular feature has been implemented within the system, as well as an overall grasp of the user interface.

Comparing the **persuasive features** of the websites focused on the general presentation of EHR content. Elements affected by individual browsers or personal style (such as colours and fonts) were excluded. Two main categories were included:

- **Directional text.** Text that encourages the user to identify with the system through the use of possessives, such as “your organization” or “your patients”. This type of text also identifies the user population that the website is targeted towards, such as clinicians or administrators. The use of specialized terminology, or jargon, was also considered.

- **Ease of Navigation.** A measure of the difficulty in getting from the vendor’s homepage to their EHR system homepage, using the number of links that need to be followed. Multiple values indicated more than one possible navigation path. This category can indicate the prominence of the EHR system within the company, and the ability of potential customers to easily access information about the system.
5.2.3.2 Comparison 2: Vendor Websites and OntarioMD Information

This comparison of online sources of information about EHR systems was only performed for primary care systems that were certified by OntarioMD (n = 12). Systems with multiple certified versions (e.g., locally installed or ASP) were considered a single entity for comparison. Certified systems have webpages on the OntarioMD site that give vendors the opportunity to provide detailed information to physicians in Ontario who are planning to buy a primary care EHR system. There is no analogous website for acute care systems, and therefore no reliable source to carry out this comparison in acute care systems. Based on the OntarioMD information, 14 data points for each certified primary care system were collected (168 in total), and each point was checked to see if it also appeared on the corresponding vendor’s website.

5.2.3.3 Comparison 3: Information About System Features

The third area of investigation was the comparison of information related to EHR system features and specifications across both primary and acute care systems, especially as they related to multimedia content, for all 21 systems. This information was compiled from website text (feature lists or descriptors within text) and non-textual features, such as screenshots or other graphics. Any further features listed on the OntarioMD site were also included in the analysis.

The eight core functionalities of an EHR (as defined by the IOM, 2003) were used to classify data and provide an overview of information related to system scope. The IOM core functionalities used to identify system scope were:

- health information and data (not including interface design): e.g. demographic data
- results management: e.g. images, clinical dashboard and alerts
- order entry and management: e.g. CPOE, prescribing
- decision support: e.g. drug interactions, prevention and detection alerts
- electronic communication and connectivity: e.g. email, integrated records
- patient support: e.g. patient education
- administrative processes: e.g. patient scheduling, billing
- reporting and population health management: e.g. quality indicators, national registries

The IOM definition does not include technical system aspects such as security, privacy, or system audits.

If a system description included one or more features fitting the functionality description, it was considered to meet that requirement. If features were not explicitly mentioned, they were not considered present in the comparison. For instance, a website not stating that patient data were stored or displayed by the system would not meet the first functionality, even though it would be reasonable to assume that the system must contain some patient data in order for any other functions to operate.

Additionally, all of the vendors were also examined for information on their incorporation of multimedia (MM) features, ranging from the ability to store and display different types of information to compatibility with peripherals encouraging multimedia use. All functions that involved the display of information using more than one type of media (combinations of text, image, audio, and video) were included.

### 5.2.3.4 Summary of Vendor Website Analysis

This analysis of vendor websites resulted in a detailed comparison of online information and multimedia capabilities for commercial EHR offerings. Additionally, it employed the assumption that websites can be sources of both explicit information (such as text) and implicit information (such as the importance vendors place on establishing their credibility). Assuming that vendors maintain a coherent design strategy across their products (websites and EHR systems), the website data provide insight into the priorities that influence EHR system development.

### 5.3 Physician Survey
5.3.1 Dependent Variables and Constructs

For the purposes of this survey, “multimedia” was separated into three types of media features: still images, audio-only recordings, and audiovisual (video) recordings. This provided a granular way of eliciting accurate opinions, while allowing us to consider overall perceptions of multimedia by adding the categories together. Using these categories also ensured that the participants did not mistake discussion of advanced MMEHRs with EHR systems that only integrate diagnostic images and textual data.

Within the TAM framework, the perceived usefulness (PU) and intention to use (I) variables were chosen for study. Perceived ease of use (PEOU) was excluded from the study, as study participants did not have the opportunity to review a specific system and assess its ease of use. Additionally, actual use of an MMEHR was not included, as there was no evaluation of an existing system. The PU-I relationship is considered a strong predictor of actual use of technology (Davis, 1989), making it useful for estimating future use of a system feature before the development process is complete.

Therefore, investigating multimedia PU and I resulted in eight dependent variables as shown in Table 1:

Table 1

<table>
<thead>
<tr>
<th>Description of Dependent Variables Used in the Physician Survey</th>
<th>Perceived usefulness</th>
<th>Intention to use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image features</td>
<td>ImgPU</td>
<td>ImgI</td>
</tr>
<tr>
<td>Audio features</td>
<td>AudPU</td>
<td>AudI</td>
</tr>
<tr>
<td>Video features</td>
<td>VidPU</td>
<td>VidI</td>
</tr>
<tr>
<td>Total (mean of image, audio, and video)</td>
<td>TotalPU</td>
<td>TotalI</td>
</tr>
</tbody>
</table>

ImgPU and ImgI refer to the PU and I determined for image features. Similarly, AudPU and AudI correspond to PU and I for audio features, and VidPU and VidI refer to PU and I for video features. TotalPU is calculated as the mean of ImgPU, AudPU, and VidPU and
represents an overall measure of multimedia PU. TotalI is a measure of the overall multimedia I and is derived from the mean of ImgI, AudI, and VidI.

5.3.2 Independent Variables

The survey measured eight independent variables, which were external factors that could potentially affect the dependent variables. There were four groups of self-reported variables, selected based on previous research (see sections 2.4.3, 3.1.3, 3.3):

1. Demographics: participants’ age and gender;
2. Clinical expertise: specialty and years of experience;
3. Computing experience: General computing, EHR-specific computing, and number of EHR systems used; and
4. Satisfaction with the EHR system(s) in current use.

To account for the wide variety of clinical specialties that could be listed by participants, a predefined list of 15 options (seen in Table 2) was presented and participants were asked to select the single category that most accurately represented their specialty. A clinician assisted in creating this list by taking the list of residency programs provided by the Royal College of Physicians and Surgeons of Canada (RCPSC, 2011) and removing specialties not applicable to UHN. During data analysis, these specialties were grouped into two broader categories, with each of the fifteen options being classified as either Medical or Surgical. Since a published authoritative classification could not be located, a clinician also assisted in the categorization.
Table 2

*Categorization of Clinical Specialty Options Presented on the Survey*

<table>
<thead>
<tr>
<th>Clinical Specialty Category</th>
<th>Clinical Specialty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical</td>
<td>Cardiac Surgery</td>
</tr>
<tr>
<td></td>
<td>General Surgery</td>
</tr>
<tr>
<td></td>
<td>Neurosurgery</td>
</tr>
<tr>
<td></td>
<td>Ophthalmology</td>
</tr>
<tr>
<td></td>
<td>Orthopedic Surgery</td>
</tr>
<tr>
<td></td>
<td>Otolaryngology</td>
</tr>
<tr>
<td></td>
<td>Plastic Surgery</td>
</tr>
<tr>
<td></td>
<td>Urology</td>
</tr>
<tr>
<td>Medical</td>
<td>Dermatology</td>
</tr>
<tr>
<td></td>
<td>Emergency Medicine</td>
</tr>
<tr>
<td></td>
<td>Internal Medicine</td>
</tr>
<tr>
<td></td>
<td>Medical Genetics</td>
</tr>
<tr>
<td></td>
<td>Neurology</td>
</tr>
<tr>
<td></td>
<td>Physical Medicine</td>
</tr>
<tr>
<td></td>
<td>Psychiatry</td>
</tr>
</tbody>
</table>

5.3.3 Relationships between Variables

The physician survey was designed to investigate possible relationships between external factors and the PU-I relationship in TAM, as shown in Figure 4:
## 5.3.4 Population and Sampling

The survey took place over all three University Health Network (UHN) sites (Toronto General Hospital, Toronto Western Hospital, and Princess Margaret Hospital). UHN was selected due to its large size and academic affiliation with the University of Toronto. Ethics approval for the survey was obtained from the UHN Research Ethics Board and the University of Toronto Office of Research Ethics.

Within UHN, the survey population consisted of a convenience sample of physicians involved in the Telehealth Program. We collaborated with the administrative staff at the UHN Centre for Global eHealth Innovation, who facilitated access to potential participants. The Telehealth Program employs teleconferencing equipment at UHN for remote consultations in a wide variety of clinical specialties. Since telehealth users have demonstrated adoption of advanced information and communication technology, they are expected to understand the survey concepts and also be the most receptive to MMEHRs. By stratifying the general UHN population and separating out telehealth users for study, we

![Diagram of External Factors]

Figures 4. The variables under study, and how they relate to TAM.

<table>
<thead>
<tr>
<th>External Factors</th>
<th>Perceived Usefulness</th>
<th>Intention to Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td>image</td>
<td>image</td>
</tr>
<tr>
<td><em>age</em></td>
<td>audio</td>
<td>audio</td>
</tr>
<tr>
<td><em>gender</em></td>
<td>video</td>
<td>video</td>
</tr>
<tr>
<td>Clinical Expertise</td>
<td>total</td>
<td>total</td>
</tr>
<tr>
<td><em>specialty</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>years of experience</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computing Expertise</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>general</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>EHR-specific</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>number of EHRs used</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction with current EHR system</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
hoped to uncover the “best-case scenario” for introducing multimedia at UHN. Additionally, UHN has implemented an in-house EHR system for all clinical staff.

Recruitment for participation in the study was done in two steps. The initial stage invited potential participants to complete the survey online, using a link provided in a recruitment email. A follow-up email was sent out two weeks after the initial contact (the text of both emails is provided in Appendix B). All telehealth physicians were included in this stage.

Due to a very low response rate to the online survey, an additional recruitment stage was employed. Administrative support staff were approached for their assistance in increasing the survey response rate. Based on their advice, physicians received a follow-up survey in their preferred medium (paper, email, or fax). We were able to reach a small number of physicians in person as well.

Data collected from the paper and online surveys were combined into a single dataset, removing any surveys that were identified as duplicates.

5.3.5 Data Collection and Measurement Instrument

The effortless nature of creating TAM questionnaires has been further simplified with the growing popularity of electronic research methods. With the advent of free user-friendly survey engines such as SurveyMonkey.com, anyone can create and deploy an online survey to a very large or very specific population within minutes. This ease of access to technology and the ability to interface with statistical analysis software makes online surveys a valuable research tool. The increasing use of online surveys to gather information has led to work on benefits and limitations (Eysenbach & Wyatt, 2002), incentives (Delnevo, Abatemarko, & Steinberg, 2004; Zangeneh et al., 2008), and how to improve response rates (Edwards et al., 2009). This work is particularly useful for TAM studies of systems with medical applications, where a voluntary response rate from physicians may be 30% or lower (Chang, Hwang, Hung, Lin, & Yen, 2007; Chau & Hu, 2002; Tan, 2008).

The physician survey was designed as a cross-sectional, self-administered TAM questionnaire. A copy of the survey is included in Appendix C.
The first eight items were close-ended and corresponded to each of the eight independent variables. A fill-in-the-blank item was used for each variable requiring a numerical value (age, years of clinical experience, and number of EHR systems used). Participants were asked to select their gender (male or female) and clinical specialty (from a list). Acknowledging that some participants may have more than one specialty, they were asked to identify their primary specialty from a predefined list of 15 options. The two variables relating to self-rating of expertise (general computing and EHR-specific computing) were measured using a 5-point Likert scale defined as:

1. Novice
2. Advanced Beginner
3. Competent
4. Proficient

Participants’ satisfaction with their present EHR system was measured using one statement ranked on a 7-point Likert scale including: (1) Strongly Disagree, (2) Disagree, (3) Somewhat Disagree, (4) Neither Agree Nor Disagree, (5) Somewhat Agree, (6) Agree, and (7) Strongly Agree. Using a single item to measure satisfaction was preferred over existing multidimensional satisfaction constructs (e.g. Doll & Torkzadeh, 1988), in order to keep the survey concise.

The remainder of the survey was split into three identical sections, one for each of the multimedia categories. Each section described a category of multimedia features (image, audio, or video) that could be implemented in EHR systems, followed by seven 7-point Likert scale items taken from TAM (Davis et al., 1989) and one open-ended question. The open-ended question solicited comments about the proposed multimedia feature. The Likert scale items consisted of four items for PU and three for I, with one PU item and one I item reverse scaled. Each scale ranged from 1 (Strongly Disagree) to 7 (Strongly Agree). These items measured each of the dependent variables, where the value of each variable was the average value of the corresponding items.
The PU and I constructs and scales have been previously validated (Agarwal & Prasad, 2000; Davis et al., 1989; Venkatesh & Davis, 1996), and were checked for reliability (Cronbach’s alpha) during data analysis. Testing of construct validity (through factor analysis) could not be performed, due to the small sample size.

The survey was distributed in identical paper and online forms to maximize the response rate while maintaining resource efficiency.

5.3.6 Informed Consent and Confidentiality

Each copy of the survey was distributed with an informed consent statement, approved by both ethics boards (shown in Appendix C). For online questionnaires, participants were shown the statement on the first page and had to click on the “Next” button to continue to the survey. Paper survey packages included the statement, and returning the completed survey to the investigators constituted consent.

In order to preserve participant confidentiality, no personally identifying information was collected. Potential participants were given a common URL to complete the online survey on a web-based survey engine, which protected survey data against unauthorized access to the information. The Canadian survey engine AskItOnline (AskItOnline, 2011) was used to create and administer the survey online. Paper survey packages contained a pre-addressed envelope for mailing to an intermediary, giving participants additional anonymity.

5.3.7 Quantitative Data Analysis

Analysis of the quantitative data was performed using the PASW 18 statistical analysis package (formerly SPSS). Data collected through the online survey were automatically put into spreadsheet form by the survey engine (AskItOnline). All other survey responses were entered into the spreadsheet manually.

Relevant descriptive statistics and frequencies were calculated for the independent variables. The reliability (Cronbach’s alpha) of each directly measured dependent variable (ImgPU, ImgI, AudPU, AudI, VidPU, and VidI) was calculated, and items that exhibited low
correlation with other items of the same construct were excluded from further analysis (see Table 3). TotalPU and TotalI were then calculated as the mean values of the optimized constructs. Q-Q plots were used to determine that all variables had normal distributions.

Table 3

Reliability (Cronbach’s Alpha) of Directly Measured Dependent Variables

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Alpha (all items)</th>
<th>Final Alpha (corrected; some items excluded)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ImgPU</td>
<td>0.612</td>
<td>0.927</td>
</tr>
<tr>
<td>ImgI</td>
<td>0.842</td>
<td>0.880</td>
</tr>
<tr>
<td>AudPU</td>
<td>0.751</td>
<td>0.967</td>
</tr>
<tr>
<td>AudI</td>
<td>0.734</td>
<td>0.793</td>
</tr>
<tr>
<td>VidPU</td>
<td>0.703</td>
<td>0.942</td>
</tr>
<tr>
<td>VidI</td>
<td>0.881</td>
<td>0.923</td>
</tr>
</tbody>
</table>

To look for significant relationships, all Pearson correlations were calculated between each of the six continuous independent variables (age, years of clinical experience, general computing experience, EHR-specific computing experience, number of EHRs used, and satisfaction with current EHR system) and each of the eight dependent variables (total PU and total I, as well as PU and I for each of the three media).

Two-tailed t-tests were performed to look for significant differences between genders (male or female) and clinical specialty categories (medical or surgical).

Finally, hierarchical linear regression analyses were carried out to examine the fit of the data to the TAM model, and identify any external factors that significantly predicted intention to use multimedia features. The small size of the dataset precluded performing further tests, such as Partial Least Squares (PLS) or Structural Equation Modeling (SEM).

5.3.8 Qualitative Data Analysis

The survey included three open-ended questions soliciting opinions about each of the MM features described. The content of the responses was examined and coded for common themes. A second reviewer independently analyzed the comments and provided feedback that
was used to create a unified coding scheme. Responses were categorized and counted, and the resulting trends compared to the quantitative analysis.

5.4 Synthesis of Results

Employing a concurrent triangulation design enabled disparate data sources to be meaningfully combined, creating a picture of MMEHRs in Ontario that included both sides of the vendor-user relationship. The vendor review outlined the availability and prominence of MM features in selling commercial EHR systems, and the perceptions that vendors create of their systems. From the users’ point of view, the physician survey provided a perspective on how practicing clinicians perceive MM features, as well as potential factors that may influence their opinions. Integrating this information provided insight into the current state of EHR systems and context for future development of MMEHRs.
Chapter 6: Results - Vendor Website Analysis

6.1 List of Included Vendors

After examining the ITAC Health members list and OntarioMD vendors list, the vendor inclusion criteria were applied (section 5.2.2) to produce the final vendor list (shown in Table 4).

A total of 11 vendors were drawn from the OntarioMD list, and 16 more were drawn from the ITAC Health members list, for a total of 21 distinct vendors. No vendors were excluded from the OntarioMD list, while 85 organizations were excluded from the ITAC Health list. The inclusion criteria were applied to the data sources as they appeared in August 2010. The vendor website analysis was carried out in the same time period.

Since the ITAC Health members list is constantly updated, the full list of vendors was compared at the beginning and the end of the filtering process to ensure that vendors who were no longer part of ITAC Health were not included in the analysis. A comparison of the member lists from August 2010 and September 2010 showed that one organization had been added, but it did not meet the inclusion criteria. Additionally, a comparison of the member lists from October 2009 and September 2010 showed that 94 members appeared in both lists, and 37 only appeared in one. One vendor (Purkinje) was listed in 2009 but not in 2010, and so was not included for analysis here.
Table 4

Complete List of Vendors

<table>
<thead>
<tr>
<th>Vendor Name</th>
<th>Product Name</th>
<th>EHR Type</th>
<th>Vendor Homepage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABELSoft Corp.</td>
<td>ABELMed EHR-EMR/PM v11</td>
<td>P</td>
<td><a href="http://www.abelmed.com/">http://www.abelmed.com/</a></td>
</tr>
<tr>
<td>Alphaglobal-IT</td>
<td>Globe Med v1.0</td>
<td>P</td>
<td><a href="http://www.alphait.com">http://www.alphait.com</a></td>
</tr>
<tr>
<td>Alphaglobal-IT</td>
<td>Universal eHealth MD (UHM) v5.0</td>
<td>P</td>
<td><a href="http://www.alphait.com">http://www.alphait.com</a></td>
</tr>
<tr>
<td>CLINICARE Corp.</td>
<td>EliteCare v6.7</td>
<td>P</td>
<td><a href="http://www.clinicare.com/">http://www.clinicare.com/</a></td>
</tr>
<tr>
<td>Eclipsys Corp.</td>
<td>Sunrise Ambulatory Care</td>
<td>P</td>
<td><a href="http://www.eclipsys.com/">http://www.eclipsys.com/</a></td>
</tr>
<tr>
<td>EMIS Inc.</td>
<td>EMIS system</td>
<td>P</td>
<td><a href="http://www.emis.ca/">http://www.emis.ca/</a></td>
</tr>
<tr>
<td>GE Healthcare</td>
<td>Centricity</td>
<td>P</td>
<td><a href="http://www.gehealthcare.com/">http://www.gehealthcare.com/</a></td>
</tr>
<tr>
<td>Healthscreen Solutions Inc.</td>
<td>HS Practive v4.0</td>
<td>P</td>
<td><a href="http://www.healthscreen.com/">http://www.healthscreen.com/</a></td>
</tr>
<tr>
<td>(McMaster University, Department of Family Medicine)</td>
<td>OSCAR v9.06 (sometimes known as OSCAR McMaster)</td>
<td>P</td>
<td><a href="http://oscarcanada.org/">http://oscarcanada.org/</a> or <a href="http://oscarmcmaster.org/">http://oscarmcmaster.org/</a></td>
</tr>
<tr>
<td>MD Physician Services Software Inc.</td>
<td>PS Suite v5.1</td>
<td>P</td>
<td><a href="http://www.practicesolutions.ca/index.cfm/ci_id/47452/la_id/1.htm">http://www.practicesolutions.ca/index.cfm/ci_id/47452/la_id/1.htm</a></td>
</tr>
<tr>
<td>Nightingale Informatix Corp.</td>
<td>Nightingale On-Demand v8.3</td>
<td>P</td>
<td><a href="http://www.nightingalemd.ca/">http://www.nightingalemd.ca/</a></td>
</tr>
<tr>
<td>P &amp; P Data Systems Inc.</td>
<td>Clinic Information System (Clinic/Enterprise/Practice Editions, v.7.4.5)</td>
<td>P</td>
<td><a href="http://www.p-pdata.com/">http://www.p-pdata.com/</a></td>
</tr>
<tr>
<td>xwave</td>
<td>Bell Aliant xwaveEMR v8</td>
<td>P</td>
<td><a href="http://www.xwave.com/">http://www.xwave.com/</a></td>
</tr>
<tr>
<td>B Sharp Technologies Inc.</td>
<td>B Care</td>
<td>A</td>
<td><a href="http://www.bsharp.com/">http://www.bsharp.com/</a></td>
</tr>
<tr>
<td>Eclipsys Corp.</td>
<td>Sunrise Clinical Manager</td>
<td>A</td>
<td><a href="http://www.eclipsys.com/">http://www.eclipsys.com/</a></td>
</tr>
<tr>
<td>QuadraMed Corp.</td>
<td>QCPR</td>
<td>A</td>
<td><a href="http://www.quadramed.com/">http://www.quadramed.com/</a></td>
</tr>
</tbody>
</table>

*a Type of EHR system being analyzed: primary care (P) or acute care (A)
6.2 Comparison 1: Vendor-Produced Websites

The websites for primary and acute care EHR system vendors were evaluated for comprehensiveness and persuasive features. The main findings are presented in Table 5 and discussed below.
### Table 5

**Comparison of Information on All EHR Vendor Websites**

<table>
<thead>
<tr>
<th>Vendor (System)</th>
<th>EHR type</th>
<th>Last update</th>
<th>Affiliates</th>
<th>Client support</th>
<th>Non-textual data</th>
<th>Client testimonials</th>
<th>Product demos</th>
<th>Topics discussed</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABELSoft (ABELMed)</td>
<td>P 2010</td>
<td>ONMD, MS</td>
<td>24/7 helpdesk</td>
<td>Stock images</td>
<td>-- Y -- --</td>
<td>-- -- --</td>
<td>Y -- Y --</td>
<td></td>
</tr>
<tr>
<td>AlphaIT (GlobeMed)</td>
<td>P 2010</td>
<td>--</td>
<td>Client section (login)</td>
<td>Video (login)</td>
<td>Y -- --</td>
<td>-- O --</td>
<td>-- -- -- --</td>
<td></td>
</tr>
<tr>
<td>AlphaIT (UHM)</td>
<td>P 2010</td>
<td>--</td>
<td>Client section (login)</td>
<td>Video</td>
<td>Y -- --</td>
<td>-- Y --</td>
<td>-- -- -- --</td>
<td></td>
</tr>
<tr>
<td>Clinicare (EliteCare)</td>
<td>P 2008</td>
<td>IBM</td>
<td>Support section</td>
<td>Screenshots</td>
<td>-- Y --</td>
<td>Y --</td>
<td>-- -- -- --</td>
<td>Practice disruption, scalability</td>
</tr>
<tr>
<td>Eclipsys (Sunrise Ambulatory Care)</td>
<td>P 2010</td>
<td>--</td>
<td>Standard only</td>
<td>Stock images</td>
<td>-- -- --</td>
<td>-- --</td>
<td>Y Y --</td>
<td>Practice disruption, scalability</td>
</tr>
<tr>
<td>EMIS</td>
<td>P 2010</td>
<td>MS, HP</td>
<td>Standard only</td>
<td>Video</td>
<td>-- Y --</td>
<td>Y --</td>
<td>-- --</td>
<td>Corporate stability, practice disruption</td>
</tr>
<tr>
<td>GE (Centricity)</td>
<td>P 2010</td>
<td>--</td>
<td>Customer portal (login)</td>
<td>Video (login)</td>
<td>-- -- O</td>
<td>-- O</td>
<td>Y Y --</td>
<td>Corporate stability, practice disruption</td>
</tr>
<tr>
<td>Vendor (System)</td>
<td>EHR type</td>
<td>Last update</td>
<td>Affiliates</td>
<td>Client support</td>
<td>Non-textual data</td>
<td>Client testimonials</td>
<td>Product demos</td>
<td>Topics discussed</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------</td>
<td>-------------</td>
<td>---------------------------------</td>
<td>----------------------------</td>
<td>------------------</td>
<td>---------------------</td>
<td>---------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Healthscreen (HS Practice)</td>
<td>P</td>
<td>2008</td>
<td>OMA, COFP</td>
<td>Physician section (login)</td>
<td>Stock images</td>
<td>Blank page</td>
<td>Image</td>
<td>Y -- Y --</td>
</tr>
<tr>
<td>Jonoke (JonokeMed)</td>
<td>P</td>
<td>2009</td>
<td>BBB, Apple, CHITTA, Dell, LaCie</td>
<td>Client section (login)</td>
<td>Screenshots</td>
<td>Short text</td>
<td>Video</td>
<td>Y -- Y -- Y --</td>
</tr>
<tr>
<td>Nightingale (On-Demand)</td>
<td>P</td>
<td>2010</td>
<td>ONMD</td>
<td>Client section (login), unlimited tech support, documentation</td>
<td>Video (login)</td>
<td>Long text</td>
<td>Video</td>
<td>Y -- O --</td>
</tr>
<tr>
<td>Optimed (Accuro)</td>
<td>P</td>
<td>2010</td>
<td>Clinicare</td>
<td>Standard only</td>
<td>Stock images</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>OSCAR</td>
<td>P</td>
<td>2010</td>
<td>ONMD, McMaster</td>
<td>Not standard; user society, listservs, blog</td>
<td>Screenshots</td>
<td>--</td>
<td>--</td>
<td>Y -- Y O --</td>
</tr>
<tr>
<td>P&amp;P Data Systems (CIS)</td>
<td>P</td>
<td>2010</td>
<td>ONMD, Dell, MS, HP, Sun</td>
<td>Client section (login), remote desktop</td>
<td>Screenshot</td>
<td>--</td>
<td>--</td>
<td>Y -- Y --</td>
</tr>
<tr>
<td>Practice Solutions (PS Suite)</td>
<td>P</td>
<td>2010</td>
<td>CMA, ONMD</td>
<td>Client portal (login)</td>
<td>Video</td>
<td>--</td>
<td>--</td>
<td>Y -- Y -- Y</td>
</tr>
<tr>
<td>xwave (xwaveEMR)</td>
<td>P</td>
<td>2009</td>
<td>Bell Aliant, GE, ONMD, ITAC Health</td>
<td>Client section (login), helpdesk</td>
<td>Video</td>
<td>--</td>
<td>--</td>
<td>Y -- Y Y Y</td>
</tr>
</tbody>
</table>

1. Corporate stability, privacy, training
2. Transitioning from paper
3. Open source, support
4. Support
5. Connectivity, mobility, security
6. Corporate stability, support
<table>
<thead>
<tr>
<th>Vendor (System)</th>
<th>EHR type</th>
<th>Last update</th>
<th>Affiliates</th>
<th>Client support</th>
<th>Non-textual data</th>
<th>Client testimonials</th>
<th>Product demos</th>
<th>Topics discussed</th>
</tr>
</thead>
<tbody>
<tr>
<td>York-Med (MD Suite)</td>
<td>P</td>
<td>2007</td>
<td>ONMD</td>
<td>Helpdesk, webcasts</td>
<td>Stock images</td>
<td>-- Y -- --</td>
<td>-- -- --</td>
<td>-- -- Y --</td>
</tr>
<tr>
<td>B Sharp (B Care)</td>
<td>A</td>
<td>2009</td>
<td>MS, Sun, client list</td>
<td>Standard only</td>
<td>Stock images</td>
<td>-- Y -- --</td>
<td>-- -- --</td>
<td>-- Y --</td>
</tr>
<tr>
<td>Cerner (PowerChart)</td>
<td>A</td>
<td>2010</td>
<td>CCHIT</td>
<td>Standard only</td>
<td>Stock images</td>
<td>-- -- -- --</td>
<td>-- -- --</td>
<td>-- Y --</td>
</tr>
<tr>
<td>Eclipsys (Sunrise Clinical Manager)</td>
<td>A</td>
<td>2010</td>
<td>--</td>
<td>Standard only</td>
<td>Stock images</td>
<td>-- -- -- --</td>
<td>-- -- --</td>
<td>Y Y --</td>
</tr>
<tr>
<td>QuadraMed (QCPR)</td>
<td>A</td>
<td>n/a</td>
<td>HIMSS, AHIMA</td>
<td>Client section (login)</td>
<td>Webcasts (login)</td>
<td>Y -- -- --</td>
<td>-- -- --</td>
<td>Y Y --</td>
</tr>
<tr>
<td>Telus (oacis)</td>
<td>A</td>
<td>2010</td>
<td>--</td>
<td>Only phone, email</td>
<td>Screenshots</td>
<td>-- -- -- Y</td>
<td>Y Y -- --</td>
<td>Y Y Y --</td>
</tr>
<tr>
<td>Total</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>3 9 4 3</td>
<td>5 7 1 10 10 10 6</td>
<td>--</td>
</tr>
</tbody>
</table>

*a Type of EHR system being analyzed: primary care (P) or acute care (A)

b 1: Quality of care
c 2: Integration/interoperability
d 3: Costs/Return on investment
e 4: Practice efficiency/productivity

f (login): viewer must be logged in
Y: Website contains feature
O: Website contains feature, but viewer must be logged in
--: Website does not contain feature

Note. Acronyms used for affiliates: ONMD (OntarioMD), MS (Microsoft), HP (Hewlett-Packard), OMA (Ontario Medical Association), COFP (College of Ontario Family Physicians), BBB (Better Business Bureau), CHITTA (now ITAC Health), CMA (Canadian Medical Association), GE (General Electric), CCHIT (Certification Commission for Health Information Technology), HIMSS (Healthcare Information and Management Systems Society), AHIMA (American Health Information Management Association). Client support includes standard contact information (section 5.2.3.1) unless otherwise stated.
6.2.1 Comprehensiveness

6.2.1.1 Last Updated

The year in which each website was last updated was recorded from the page footer copyright information (e.g. “© 2010”), since none of the sites evaluated had more specific dates available. The majority of sites were updated in 2010 (11 of 16 primary care vendors, and 3 of 5 acute care vendors). Of the seven remaining sites, five were updated in 2008 or 2009, one was updated in 2007, and one had no update information.

6.2.1.2 Affiliates and Certification

Most of the vendors noted affiliations with technology companies or health-related associations on their websites. Six vendors did not have any affiliates or partners listed. Of the three acute care vendors who mentioned other organizations, Cerner and QuadraMed listed American healthcare associations (the Certification Commission for Healthcare Information Technology and the American Health Information Management Association, respectively). The third vendor, B Sharp, listed affiliations with technology companies such as Microsoft and Sun, and displayed a client list of Ontario healthcare organizations.

Eight of the twelve primary care vendors with systems certified by OntarioMD mentioned this certification. However, this certification was not emphasized by most vendors and was separated from information about the system or only mentioned as a news item; only ABELMed conspicuously displayed the OntarioMD logo on its homepage. Seven primary care vendors listed affiliations with technology companies such as Dell and Microsoft. A number of health organizations were seen as well, such as the Ontario Medical Association (Healthscreen) and CHITTA/ITAC Health (Jonoke and xwave). Additionally, the Canadian Medical Association and McMaster University are unique in that they are the parent organizations of Practice Solutions and OSCAR, respectively.
6.2.1.3 Customer Testimonials

Most vendors had some form of testimonial on their website. Seven of the 21 systems did not have testimonials, and of these, only Cerner and Eclipsys did not have space set aside for future testimonials. GE claimed to have comments from clinicians available to registered users, while the other three systems had blank testimonial pages. Of the fourteen systems with testimonials, twelve of these were for primary care systems. Only two of the acute care vendors had testimonials (B Sharp and Telus), and one of these was on a PDF brochure instead of on the site page itself.

The most common form of testimonial was a short quote, often with part or all of the user’s name and organization, such as the example shown in Figure 5.

![Customer testimonial seen on the Clinicare homepage (Clinicare, 2011).](image)

Some vendors extended the testimonials into case studies, going more in depth into the client’s practice and implementation. EMIS and Telus each used a video testimonial instead of text. Figure 6 depicts the banner link leading to the EMIS video testimonial, taken from the EMIS homepage.
6.2.1.4 Customer Support

When evaluating the vendor’s customer support, it was assumed that all vendors would put up at least a “standard” amount of contact information: phone number, online contact, mailing address, and possibly a fax number. Only two vendors did not fulfill this requirement: OSCAR, which does not have a central location or head office, and Telus, which only provided a phone number and email address. Of the acute care vendors, only QuadraMed went beyond the standard information to include a client-only section.

In contrast, a number of primary care vendors provided 24/7 support in the form of phone lines or online help. One vendor (York-Med) advertised regular continuing education webcasts for clients. 13 of the 16 vendors provided some sort of client-only section on their website, presumably containing documentation and resources. One of them (P&P Data Systems) listed the contents of their client section, as seen in Figure 7. Other vendors may have standalone support sites, but this could not be verified.
OSCAR did not provide conventional contact information, but as an open source project there are listservs and blogs providing online support. Free membership in the OSCAR User Society is also encouraged to connect with other users, and the software source code is freely available. Third-party service providers, such as ClearMedica (ClearMedica, 2011a), support OSCAR implementations on a paid basis.

6.2.1.5 Topics Discussed

With the exception of Clinicare, all of the vendors included general discussions surrounding the adoption of EHRs and implications for practice. All five acute care vendors discussed integration of data within an organization or with external organizations, and three also related this integration to improved quality of care and resource efficiency or productivity.

The primary care vendors’ topics related to how clinicians practice using an EHR and how it changes administration of their practice. Seven of the fifteen vendors who presented
supplemental information touched upon the transition from paper charts to electronic records and the disruptive effects on clinicians and non-clinical staff. Related to this, a number of vendors also emphasized the training and support they provide to ease the transition and ensure that physicians are able to use EHRs comfortably. Interestingly, not many of the vendors discussed the possibility of converting existing electronic data for use, even though the transfer of data is an important part of transitioning to a new system. It was more common for vendors to state that paper charts could be scanned into the system. For example, Jonoke writes, “… paper charts can be scanned and archived as pristine image copies, available for retrieval at any time.” (Jonoke, 2011) While this solution gets patient data into the system, the images may not be processed in a way that allows the actual information to be pulled into a database.

Another well-represented topic among primary care vendors was the cost of the system and the potential return on investment, which was discussed by nine vendors. While none of the vendors quoted a price for their product (except for OSCAR, which is free), many stated that their systems would help offset costs through efficient billing and administration. For instance, ABELMed states, “Fee for Service physicians … will see an immediate improvement in cash flow, which can lead to significant savings to the practice over time.” (ABELMed Inc., 2011) Healthscreen provides a testimonial from a client using their billing functions in Figure 8.

Thanks for all your help!
I'm now earning the income that I ignored previously. Without CallerMD, I would have had to hire staff to collect it.

—Dr. Anthony Wells
6.2.1.6 Non-textual Information (Multimedia)

Examining the vendors’ use of multimedia on their sites showed that most information was provided in text, not images or videos. Of the five acute care vendors, only one (Telus) provided any screenshots of their system. Telus also posted a video testimonial, and QuadraMed’s library of webcasts is only available to registered users.

Primary care vendors show slightly more use of non-textual information. Of the sixteen primary care systems, five showed only basic logo and filler images outside of the text. Screenshots of the system interface were available for 4 systems: Clinicare, Jonoke, OSCAR, and P&P Data Systems. Half of the vendors used some form of video on their site, whether publicly or within a client-only login. This ranged from a video testimonial from EMIS and YouTube videos from OSCAR to a personalized virtual tour from GE. Three of the eight vendors with videos required registration or a login prior to viewing. This generally involved filling in some basic personal information, such as in Figure 9. The single most media-intensive site was OSCAR, which posted videos, screenshots, and an extensive slide-based system walkthrough.
6.2.1.7 Product Demos

In order to give potential customers a better idea of their product, some vendors provided a demonstration of their system interface. Four systems posted only screenshots, while ten more did not provide any non-textual information. Three vendors posted videos that were only available to viewers who logged into the site, and four had publicly available video demos. Of these four (AlphaIT UHM, OSCAR, Practice Solutions PS Suite, and xwaveEMR), only AlphaIT UHM and OSCAR went beyond a slideshow format and showed the system in active use, such as in Figure 10. OSCAR also has a system walkthrough video posted on YouTube (―OSCAR Intro‖, 2008), and an openly available live demo site (ClearMedica, 2011b). The full version of OSCAR can also be freely downloaded.

Figure 9. User registration form for viewing GE Centricity’s demo (GE Centricity, 2011).
6.2.2 Persuasive Features

6.2.2.1 Targeted Content

The use of text speaking directly to the intended audience was prevalent across vendor websites, with the single exception of the QuadraMed site. Other sites discussed their systems in relation to “your practice” (AlphaIT) and “your organization” (Cerner PowerChart). Some primary care vendors described features from a clinician’s point of view, using statements such as “you can easily draw pathology” (ABELMed) or “you [can] add sketches or pictures to a record” (JonokeMed).

This directional text, combined with the topics of discussion, made it clear what audience each site intended to reach. The acute care vendors directed their sites to health organization executives and administration, or the people within the organization responsible for selecting...
and purchasing institutional software. In contrast, primary care sites were aimed very directly at physicians who owned their own practices, or were part of a small group practice. In the case of larger groups, there was reference to administrative staff involved in acquiring the system, but generally independent practitioners were targeted. Site content targeted towards the general public (i.e. patients) was not seen. As sites were relatively free of technical jargon (vendors such as Nightingale clearly separate technical system requirements from descriptions of the system features), these sites could be accessible to a health-literate population.

6.2.2.2 Ease of Navigation

When analyzing vendor websites, the number of clicks required to navigate from the vendor’s homepage to the system’s homepage was counted. For very small companies where the system was the only product being sold, getting to the first page describing the system generally took one or no extra clicks from the vendor’s homepage. Companies selling a range of related products and services, such as ABELSoft and B Sharp, tended to require two or three clicks to get to the EHR system. Large corporations in multiple industries (such as Telus and xwave) used a number of clicks from their homepage to get to the system, which was hosted on a separate site. Notably, GE has a healthcare-focused arm, but since GE Healthcare alone is still much larger than the other organizations being analyzed, the site still required a number of clicks to reach Centricity system information.

6.3 Comparison 2: Vendor Websites and OntarioMD Data

Since OntarioMD is designed to assist primary care physicians in adopting electronic systems, no acute care systems were included in this comparison of vendor-produced information and OntarioMD data. Systems not certified by OntarioMD were also excluded. Twelve systems were used in the comparison (Table 6).
Table 6

List of Systems Included in Comparison 2

<table>
<thead>
<tr>
<th>Vendor Name</th>
<th>Systems Included</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABELSoft</td>
<td>ABELMed</td>
</tr>
<tr>
<td>AlphaIT</td>
<td>GlobeMed</td>
</tr>
<tr>
<td>AlphaIT</td>
<td>UHM</td>
</tr>
<tr>
<td>Clinicare</td>
<td>EliteCare</td>
</tr>
<tr>
<td>Healthscreen</td>
<td>HS Practice</td>
</tr>
<tr>
<td>Jonoke</td>
<td>JonokeMed</td>
</tr>
<tr>
<td>McMaster</td>
<td>OSCAR</td>
</tr>
<tr>
<td>Nightingale</td>
<td>On-Demand (2)</td>
</tr>
<tr>
<td>P&amp;P Data Systems</td>
<td>CIS (3)</td>
</tr>
<tr>
<td>Practice Solutions</td>
<td>PS Suite (2)</td>
</tr>
<tr>
<td>xwave</td>
<td>xwaveEMR</td>
</tr>
<tr>
<td>York-Med</td>
<td>MD Suite</td>
</tr>
</tbody>
</table>

* Numbers in brackets indicate the number of system versions listed in ONMD

The amount of overlap between the OntarioMD and vendor-owned websites was determined, as seen in Table 7. OntarioMD’s information is highly uniform across vendors, so the categories that OntarioMD used served as the basis for comparison (e.g., OntarioMD, 2011b). At least one question from each general category was included in the comparison. The OntarioMD dataset was complete for all but five of the questions included (size of user base, bilingual software, membership in a Vendor Collaborative Network, licensing from Health Canada, and user ratings), so the comparison focused on whether the vendors’ own websites covered the same questions.
### Table 7

**Overlap Between Vendor Websites and OntarioMD Information**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of user base</td>
<td>O</td>
<td>--</td>
<td>Y Y</td>
<td>O Y O Y O</td>
<td>Y Y Y Y</td>
<td>Y Y</td>
<td>Y Y</td>
<td>Y</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>6</td>
</tr>
<tr>
<td>Training program</td>
<td>O</td>
<td>Y Y O Y</td>
<td>Y Y</td>
<td>O Y Y Y Y Y</td>
<td>Y Y Y Y</td>
<td>Y Y</td>
<td>Y Y</td>
<td>Y</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>8</td>
</tr>
<tr>
<td>Support program</td>
<td>Y</td>
<td>Y Y Y O</td>
<td>Y Y</td>
<td>O Y O Y Y Y</td>
<td>Y Y Y Y</td>
<td>Y Y</td>
<td>Y Y</td>
<td>Y</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>9</td>
</tr>
<tr>
<td>Frequency of system upgrades</td>
<td>O</td>
<td>Y Y Y O</td>
<td>O Y</td>
<td>O Y O Y O</td>
<td>O O O O</td>
<td>O Y</td>
<td>Y Y</td>
<td>Y</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4</td>
</tr>
<tr>
<td>Conversion of electronic data</td>
<td>Y</td>
<td>Y Y Y O</td>
<td>O O</td>
<td>O O O Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y Y</td>
<td>O Y</td>
<td>Y</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>6</td>
</tr>
<tr>
<td>Health card validation</td>
<td>Y</td>
<td>Y Y Y O</td>
<td>O Y</td>
<td>Y O Y Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y Y</td>
<td>Y Y</td>
<td>Y</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
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<td>Y</td>
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<td>7</td>
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<tr>
<td>Data entry templates</td>
<td>Y</td>
<td>Y Y Y Y</td>
<td>Y Y</td>
<td>Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y Y</td>
<td>Y Y</td>
<td>Y</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>12</td>
</tr>
<tr>
<td>Bilingual interface</td>
<td>--</td>
<td>-- -- -- --</td>
<td>-- --</td>
<td>-- -- -- -- --</td>
<td>--</td>
<td>--</td>
<td>-- --</td>
<td>--</td>
<td>-- -- -- -- -- -- -- --</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>2</td>
</tr>
<tr>
<td>Clinical coding systems</td>
<td>Y</td>
<td>Y Y Y Y</td>
<td>O Y</td>
<td>Y Y O Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y Y</td>
<td>Y Y</td>
<td>Y</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>10</td>
</tr>
<tr>
<td>Configuration specifications</td>
<td>Y</td>
<td>O O O O</td>
<td>O Y</td>
<td>Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y Y</td>
<td>Y Y</td>
<td>Y</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4</td>
</tr>
<tr>
<td>Remote server management</td>
<td>Y</td>
<td>Y Y Y O</td>
<td>O O</td>
<td>O Y O Y O Y</td>
<td>O</td>
<td>O O</td>
<td>O O</td>
<td>O</td>
<td>O O O O O O O Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>6</td>
</tr>
<tr>
<td>Vendor Collaborative Network (VCN) member</td>
<td>O</td>
<td>-- -- -- --</td>
<td>-- O</td>
<td>-- -- -- -- --</td>
<td>--</td>
<td>--</td>
<td>-- --</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>Health Canada medical device licensing</td>
<td>O</td>
<td>-- -- -- --</td>
<td>-- --</td>
<td>-- -- -- -- --</td>
<td>--</td>
<td>--</td>
<td>-- --</td>
<td>--</td>
<td>-- -- -- -- -- -- -- --</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>CanadianEMR rating</td>
<td>O</td>
<td>-- -- -- --</td>
<td>Y O</td>
<td>O O O O O O</td>
<td>O</td>
<td>O O</td>
<td>O O</td>
<td>O</td>
<td>O O O O O O O O</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Y</strong></td>
<td>7</td>
<td>8 8 6</td>
<td>3 7 6</td>
<td>6 7 5 7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

**Notes:**
- Y: Information appears on both OntarioMD and the vendor website
- O: Information only appears on OntarioMD
- --: Information not applicable to the system or neither source provides information
6.3.1 User Information

For both data sources (OntarioMD and the corresponding vendor website), AlphaIT did not provide the size of their user base for either of their systems. Of the remaining ten systems, six listed their number of users in both places, and four only displayed the information on OntarioMD.

Two of the twelve systems did not have CanadianEMR ratings (user ratings) listed on OntarioMD. Of the remaining systems, only Clinicare posted their rating on their website.

6.3.2 Start-up, Maintenance, and Technical Details

Two-thirds (8 of 12) of the vendors provided some detail about their training process on their websites, while nine vendors discussed their support services on their sites. Details of Clinicare’s support program were not publicly available. Half of the vendors included their ability to import existing electronic data into their systems on their own websites.

Four vendors mentioned how often their software is updated, and Clinicare did not make the information publicly available on its website. Four vendors included configuration details on their websites, detailing the hardware and software requirements for running the system. In some cases, optional peripherals were also included, such as barcode scanners. Six vendor websites mentioned the ability to set up a remote server for backup and/or vendor-directed server management. Three of the vendors are part of Vendor Collaborative Networks (VCNs), and only P&P Data Systems noted this on their website.

6.3.3 System Features

Four of the twelve vendors stated that their systems can automatically validate Ontario health cards, either in real time or in batches. Practice Solutions (owned by the CMA) offers English and French versions of their software, and OSCAR is only certified by OntarioMD in English, but the software is available in multiple languages. The other ten vendors do not offer non-English interfaces. All twelve vendor websites mentioned that their systems
include predefined data entry templates. Ten of the vendors mentioned some sort of clinical coding ability on their websites, usually including what standard is used (e.g. ICD-10).

Only P&P Data Systems has a Class II medical device license from Health Canada, and their website emphasizes their licensed status.

6.3.4 Summary

The major finding of this comparison was that the vendor websites only contain a subset of the data gathered from the OntarioMD site. None of the vendors included all of their OntarioMD information on their own website. Of the fourteen points of comparison between the OntarioMD data and the vendor websites, only the inclusion of templates and bilingual interfaces are fully represented in both data sources. For all of the other categories, the vendor websites were less complete than the OntarioMD site. None of the data missing from the OntarioMD information were subsequently found on vendor websites, and the vendor websites often did not go into as much detail as OntarioMD did. This was particularly noticeable for technical configuration specifications, which were broken down into optimal implementations for three specific scenarios in OntarioMD. Sites that provided configuration details, such as OSCAR and ABELMed, tended to provide general guidelines regarding compatible equipment and leave details such as the number of computers required to the discretion of the practice.

The vendor websites are known to have changed since the data for this comparison were collected. Some vendors, such as Nightingale and ABELMed, have updated their websites and now include more of the OntarioMD topics.

As in the previous comparison of vendor websites to each other, the OSCAR system is different from the other vendors. Although it lists McMaster University as its vendor in OntarioMD, this is not the same vendor-product relationship as other systems. A number of the categories from the OntarioMD site are not truly applicable to an open source system, since third-party providers would handle services such as remote server management and
backup, not McMaster, unless the university has created a spinoff service provider (and this does not seem to be the case).

6.4 Comparison 3: System Features and Multimedia

All 21 systems (16 primary care and 5 acute care) were compared for information about general features, and more specifically for multimedia capabilities and potential. The data were drawn from the vendor websites, as well as OntarioMD data if applicable. General features were assessed using eight core functionalities: health information and data, results management, order entry and management, decision support, electronic communication and connectivity, patient support, administration, and reporting.

6.4.1 Scope of System Features

Based on the website information, each system was evaluated for the presence of at least one feature in each of the eight EHR functionalities (or components) as defined by the IOM, as shown in Table 8. Many systems contained more than one feature within a single category; for example, AlphaIT GlobeMed possesses scheduling and billing functions, which both fall under the administration component.
Table 8

*System Scope, Based on Website Information and Classified by IOM Core Functionalities*

<table>
<thead>
<tr>
<th>Vendor (System)</th>
<th>EHR type a</th>
<th>Health information &amp; data</th>
<th>Results management</th>
<th>Order entry/management</th>
<th>Decision support</th>
<th>Electronic communication &amp; connectivity</th>
<th>Patient support</th>
<th>Administrative processes</th>
<th>Reporting &amp; population health management</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABELSoft (ABELMed)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>8</td>
</tr>
<tr>
<td>AlphaIT (GlobeMed)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>7</td>
</tr>
<tr>
<td>AlphaIT (UHM)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>--</td>
<td>7</td>
</tr>
<tr>
<td>Clinicare (EliteCare)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>--</td>
<td>--</td>
<td>5</td>
</tr>
<tr>
<td>Eclipsys (Sunrise Ambulatory Care)</td>
<td>P</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>--</td>
<td>--</td>
<td>5</td>
</tr>
<tr>
<td>EMIS</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>--</td>
<td>--</td>
<td>6</td>
</tr>
<tr>
<td>GE (Centricity)</td>
<td>P</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>5</td>
</tr>
<tr>
<td>Healthscreen (HS Practice)</td>
<td>P</td>
<td>Y</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>Y</td>
<td>3</td>
</tr>
<tr>
<td>Jonoke (JonokeMed)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>8</td>
</tr>
<tr>
<td>Nightingale (On-Demand)</td>
<td>P</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>6</td>
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<tr>
<td>Optimed (Accuro)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<td>--</td>
<td>Y</td>
<td>--</td>
<td>--</td>
<td>5</td>
</tr>
<tr>
<td>OSCAR</td>
<td>P</td>
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<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>8</td>
</tr>
<tr>
<td>P&amp;P Data Systems (CIS)</td>
<td>P</td>
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<td>Y</td>
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<td>--</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>7</td>
</tr>
<tr>
<td>Practice Solutions (PS Suite)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>8</td>
</tr>
<tr>
<td>xwave (xwaveEMR)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>8</td>
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<tr>
<td>York-Med (MD Suite)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>--</td>
<td>Y</td>
<td>7</td>
</tr>
<tr>
<td>B Sharp (B Care)</td>
<td>A</td>
<td>Y</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>Y</td>
<td>3</td>
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<tr>
<td>Cerner (PowerChart)</td>
<td>A</td>
<td>--</td>
<td>--</td>
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<td>Y</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>2</td>
</tr>
<tr>
<td>Eclipsys (Sunrise Clinical Manager)</td>
<td>A</td>
<td>--</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>Y</td>
<td>5</td>
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<td>QuadraMed (QCPR)</td>
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<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>7</td>
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<td>Telus (oacis)</td>
<td>A</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>Y</td>
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<td><strong>Total</strong></td>
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<td><strong>15</strong></td>
<td><strong>19</strong></td>
<td><strong>17</strong></td>
<td><strong>18</strong></td>
<td><strong>8</strong></td>
<td><strong>17</strong></td>
<td><strong>13</strong></td>
<td><strong>13</strong></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>

a Type of EHR system being analyzed: primary care (P) or acute care (A)
Y: Website claims that the system has this functionality
--: Website does not claim that the system has this functionality
Among the five acute care systems represented, no system’s website presented all eight components. QuadraMed’s QCPR noted seven functionalities, while the Cerner PowerChart only met two, based on their respective websites. Furthermore, no single component was seen in all five systems. The importance of communication between providers was emphasized, with four systems’ websites noting some form of secure electronic mail or messaging, as well as the ability to order tests or receive results electronically. Clinical decision support, such as drug-drug interactions, was also claimed on four of the five websites.

In contrast, many of the websites for primary care systems featured seven or all eight of the EHR components. ABELMed, JonokeMed, OSCAR, Practice Solutions PS Suite, and xwaveEMR had all functionalities, while another four systems were only missing one component. Primary care systems generally presented more components presented than acute care systems, highlighted by the fact that all 16 primary care systems met the definition for the health information and administration functionalities.

The least commonly found component on websites of both types of systems was patient education, which generally consisted of handouts and reference materials to be given to patients, outlining the details of relevant conditions, diagnoses, and treatment plans.

6.4.2 Multimedia System Features

All of the websites were examined to see if the system claimed to have multimedia (image, audio, or video) features, as shown in Table 9. These included the ability to store and display multimedia files within the system, as well as non-textual forms of input (such as scanning or dictation).
Table 9

Integration of Multimedia Features in EHR Systems as Presented by Vendor Websites

<table>
<thead>
<tr>
<th>Vendor (System)</th>
<th>EHR type</th>
<th>Input</th>
<th>Attachments</th>
<th>Mobile phone access</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABELSoft (ABELMed)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>AlphaIT (GlobeMed)</td>
<td>P</td>
<td>--</td>
<td>Y</td>
<td>--</td>
</tr>
<tr>
<td>AlphaIT (UHM)</td>
<td>P</td>
<td>--</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Clinicare (EliteCare)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
</tr>
<tr>
<td>Eclipsys (Sunrise Ambulatory Care)</td>
<td>P</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>EMIS</td>
<td>P</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>GE (Centricity)</td>
<td>P</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Healthscreen (HS Practice)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Jonoke (JonokeMed)</td>
<td>P</td>
<td>Y</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Nightingale (On-Demand)</td>
<td>P</td>
<td>--</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Optimed (Accuro)</td>
<td>P</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>OSCAR</td>
<td>P</td>
<td>Y</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>P&amp;P Data Systems (CIS)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Practice Solutions (PS Suite)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
</tr>
<tr>
<td>xwave (xwaveEMR)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>York-Med (MD Suite)</td>
<td>P</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>B Sharp (B Care)</td>
<td>A</td>
<td>--</td>
<td>--</td>
<td>Y</td>
</tr>
<tr>
<td>Cerner (PowerChart)</td>
<td>A</td>
<td>--</td>
<td>--</td>
<td>Y</td>
</tr>
<tr>
<td>Eclipsys (Sunrise Clinical Manager)</td>
<td>A</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>QuadraMed (QCPR)</td>
<td>A</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Telus (oacis)</td>
<td>A</td>
<td>Y</td>
<td>Y</td>
<td>--</td>
</tr>
</tbody>
</table>

*Type of EHR system being analyzed: primary care (P) or acute care (A)
Y: Website claims that the system has this functionality
--: Website does not claim that the system has this functionality
Of the five acute care systems, the most common multimedia feature presented was compatibility with tablets. Very few other features were identified within this group, and no systems claimed to possess audio or video file storage.

Multimedia features were more commonly presented in websites for primary care systems. Three-quarters (12 of 16) of the systems claimed the ability to graph clinical data over time, such as blood pressure readings. Input of non-textual data was also highly represented, with ten primary care systems enabling dictation or voice recognition tools, and nine supporting image scanners. Six systems asserted that physicians could sketch onto provided anatomical diagrams or create their own drawings. Incorporating digital files was also widespread, with nine systems describing some form of file attachment function. Notably, Clinicare’s EliteCare was the only system explicitly stating that audio and video files could be saved in a patient’s record.

6.4.3 Hardware Considerations

System hardware is also a factor when considering multimedia, particularly with regards to peripheral devices that create non-textual data. Ten of the 21 systems examined claimed compatibility with tablet computers, with an additional four accessible from mobile phones. The specialized input for these devices (stylus-driven or touch) lends itself to handwriting and sketching. Additionally, having microphones, speakers, and cameras built into cellphones can encourage seamless multimedia usage.

Vendors recommended peripheral devices based on the capabilities listed by the system. While document printers were suggested by all systems that listed peripherals, scanners were only suggested for systems that supported scanned images, and microphones were only suggested for systems that supported voice recognition software. Additionally, some systems did not state the devices needed to use a described feature (for example, York-Med MD Suite supports voice recognition, but does not list a microphone as a recommended peripheral). Health card readers were listed in most OntarioMD-certified systems. Four primary care systems indicated compatibility with label printers for prescriptions. Additionally, some systems noted non-multimedia related peripherals, such as biometric fingerprint scanners and patient self-serve kiosks (P&P Data Systems).
Peripheral devices supporting audio and video files were not found in the vendor recommendations. Speakers were recommended for listening to training material (ABELMed), but were not specified for listening to patient records. None of the systems mentioned compatibility with any type of camera. While this may simply mean that image and video files must be saved outside the system before being attached to a patient’s record, the lack of multimedia integration suggests that physicians are neither expected nor encouraged to use multimedia data.
Chapter 7: Results - Physician Survey

At the conclusion of the survey, 42 valid responses had been collected (a response rate of 28%). These were a mix of online and paper survey responses, which were merged into a single dataset for statistical analysis with PASW 18.

7.1 Descriptive Statistics

The sample consisted of 27 males and 15 females (64.3% and 35.7%, respectively). Average values for six other independent variables (age, clinical experience, general computing experience, EHR-specific computing experience, number of EHRs used, and satisfaction with current EHR system) are listed in Table 10. The average age of respondents was 46 years old, with approximately 15 years of clinical experience. Self-reported measures of general and EHR-specific computing experience were averaged to 3.4 and 3.3 out of 5, respectively. Respondents had used an average of 2.8 different EHR systems, and rated their satisfaction with their current system (the UHN EPR) at an average of 3 out of 5.

Table 10

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>41</td>
<td>45.71</td>
<td>10.347</td>
<td>32</td>
<td>77</td>
</tr>
<tr>
<td>Clinical experience (years)</td>
<td>40</td>
<td>14.86</td>
<td>10.597</td>
<td>2</td>
<td>47</td>
</tr>
<tr>
<td>General computing experience (scale of 1 to 5)</td>
<td>42</td>
<td>3.40</td>
<td>0.912</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>EHR computing experience (scale of 1 to 5)</td>
<td>42</td>
<td>3.33</td>
<td>0.786</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Number of EHRs ever used</td>
<td>42</td>
<td>2.83</td>
<td>1.464</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Satisfaction with current EHR (scale of 1 to 5)</td>
<td>42</td>
<td>3.02</td>
<td>0.975</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

The eighth independent variable being studied was clinical specialty, which was collapsed into a clinical specialty category as described in Table 11. Collapsing the clinical specialty into surgical or medical specialties resulted in 27 medical and 13 surgical responses (67.5% and 32.5%, respectively). Two survey participants did not indicate their specialties.
Table 11

Clinical Specialty Frequency

<table>
<thead>
<tr>
<th>Clinical specialty category</th>
<th>Clinical specialty</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical</td>
<td>Cardiac surgery</td>
<td>4 (9.5%)</td>
</tr>
<tr>
<td></td>
<td>General surgery</td>
<td>3 (7.1%)</td>
</tr>
<tr>
<td></td>
<td>Neurosurgery</td>
<td>2 (4.8%)</td>
</tr>
<tr>
<td></td>
<td>Ophthalmology</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Orthopedic surgery</td>
<td>1 (2.4%)</td>
</tr>
<tr>
<td></td>
<td>Otolaryngology</td>
<td>1 (2.4%)</td>
</tr>
<tr>
<td></td>
<td>Plastic surgery</td>
<td>1 (2.4%)</td>
</tr>
<tr>
<td></td>
<td>Urology</td>
<td>1 (2.4%)</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>13 (32.5%)</td>
</tr>
<tr>
<td>Medical</td>
<td>Dermatology</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Emergency medicine</td>
<td>1 (2.4%)</td>
</tr>
<tr>
<td></td>
<td>Internal medicine</td>
<td>10 (23.8%)</td>
</tr>
<tr>
<td></td>
<td>Medical genetics</td>
<td>2 (4.8%)</td>
</tr>
<tr>
<td></td>
<td>Neurology</td>
<td>2 (4.8%)</td>
</tr>
<tr>
<td></td>
<td>Physical medicine</td>
<td>2 (4.8%)</td>
</tr>
<tr>
<td></td>
<td>Psychiatry</td>
<td>10 (23.8%)</td>
</tr>
<tr>
<td>Subtotal</td>
<td></td>
<td>27 (67.5%)</td>
</tr>
<tr>
<td>Total respondents</td>
<td></td>
<td>40 (100%)</td>
</tr>
</tbody>
</table>

7.2 Respondent Perceptions of Perceived Usefulness and Intention to Use

Descriptive statistics of the eight dependent variables measured are presented in Table 12 and Figure 11. All of the variables had means slightly greater than 4 (the neutral value), with the exception of AudPU and AudI, which were slightly less than 4.
Table 12

Descriptive Statistics for Respondent Perceptions (Dependent Variables)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ImgPU</td>
<td>42</td>
<td>4.88</td>
<td>1.287</td>
<td>2</td>
<td>7</td>
<td>[4.48, 5.28]</td>
</tr>
<tr>
<td>ImgI</td>
<td>42</td>
<td>4.96</td>
<td>1.442</td>
<td>2</td>
<td>7</td>
<td>[4.51, 5.41]</td>
</tr>
<tr>
<td>AudPU</td>
<td>42</td>
<td>3.83</td>
<td>1.491</td>
<td>1</td>
<td>7</td>
<td>[3.37, 4.29]</td>
</tr>
<tr>
<td>AudI</td>
<td>42</td>
<td>3.89</td>
<td>1.504</td>
<td>1</td>
<td>7</td>
<td>[3.42, 4.36]</td>
</tr>
<tr>
<td>VidPU</td>
<td>42</td>
<td>4.82</td>
<td>1.397</td>
<td>2</td>
<td>7</td>
<td>[4.38, 5.26]</td>
</tr>
<tr>
<td>VidI</td>
<td>42</td>
<td>4.77</td>
<td>1.605</td>
<td>1</td>
<td>7</td>
<td>[4.27, 5.27]</td>
</tr>
<tr>
<td>TotalPU</td>
<td>42</td>
<td>4.51</td>
<td>1.101</td>
<td>2.3</td>
<td>7.0</td>
<td>[4.17, 4.85]</td>
</tr>
<tr>
<td>TotalI</td>
<td>42</td>
<td>4.54</td>
<td>1.235</td>
<td>1.7</td>
<td>6.8</td>
<td>[4.16, 4.92]</td>
</tr>
</tbody>
</table>

Figure 11. Mean of each respondent perception, shown with 95% confidence interval. Horizontal line lies at 4, the “neutral” value. Values greater than 4 indicate positive perceptions, and values less than 4 indicate negative perceptions.
7.3 Relationships between Respondent Characteristics

Correlations between independent variables were calculated for age, years of clinical experience, general computing experience, EHR-specific computing experience, and current EHR satisfaction, as shown in Table 13. These correlations indicated that age and years of clinical experience were highly correlated, and both were negatively correlated with general computing experience. Additionally, general computing experience and EHR-specific computing experience were correlated with each other as well as with current EHR satisfaction. Importantly, EHR experience and satisfaction were not correlated with age or clinical experience.

Table 13

**Pearson Correlations between Respondent Characteristics**

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>ClinicalExp a</th>
<th>GeneralExp b</th>
<th>EHRExp c</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ClinicalExp a</td>
<td>0.956 ***</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GeneralExp b</td>
<td>-0.425 ***</td>
<td>-0.522 ***</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EHRExp c</td>
<td>-0.143</td>
<td>-0.146</td>
<td>0.658 ***</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>0.081</td>
<td>-0.021</td>
<td>0.291 **</td>
<td>0.467 ***</td>
<td>1</td>
</tr>
</tbody>
</table>

a ClinicalExp: Years of clinical experience  
b GeneralExp: General computing experience  
c EHRExp: EHR-specific computing experience  
** p < 0.05 (two-tailed)  
*** p < 0.01 (two-tailed)

7.4 Relationships between Respondent Characteristics and Perceptions

Pearson correlations between each of the six continuous independent variables (age, clinical experience, general computing experience, EHR-specific experience, number of EHRs, and current EHR satisfaction) and the eight dependent variables were calculated. As shown in Table 14, no significant correlations were found for age, clinical experience, general computing experience, or number of EHRs used. A borderline significant correlation between EHR-specific computing experience and ImgPU was seen (p = 0.080). A number of negative correlations...
between the dependent variables and current EHR satisfaction showed significance or near significance. These variables were: AudI (p < 0.05), AudPU (p < 0.1), VidI (p < 0.1), TotalI (p < 0.1), VidPU (p = 0.124), and TotalPU (p = 0.124). ImgPU and ImgI were not significantly correlated with satisfaction.

Table 14

*Pearson Correlations between Respondent Characteristics and Perceptions*

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>ClinicalExp</th>
<th>GeneralExp</th>
<th>EHRExp</th>
<th>NoEHRs</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>ImgPU</td>
<td>0.102</td>
<td>0.147</td>
<td>0.104</td>
<td>0.273 **</td>
<td>0.145</td>
<td>-0.017</td>
</tr>
<tr>
<td>ImgI</td>
<td>0.085</td>
<td>0.077</td>
<td>0.085</td>
<td>0.097</td>
<td>0.049</td>
<td>-0.095</td>
</tr>
<tr>
<td>AudPU</td>
<td>-0.029</td>
<td>0.044</td>
<td>0.057</td>
<td>0.000</td>
<td>0.132</td>
<td>-0.294 **</td>
</tr>
<tr>
<td>AudI</td>
<td>-0.045</td>
<td>0.027</td>
<td>0.050</td>
<td>-0.201</td>
<td>0.069</td>
<td>-0.331 **</td>
</tr>
<tr>
<td>VidPU</td>
<td>0.026</td>
<td>0.056</td>
<td>-0.183</td>
<td>-0.239</td>
<td>-0.007</td>
<td>-0.241</td>
</tr>
<tr>
<td>VidI</td>
<td>-0.052</td>
<td>-0.006</td>
<td>-0.136</td>
<td>-0.229</td>
<td>0.041</td>
<td>-0.293 **</td>
</tr>
<tr>
<td>TotalPU</td>
<td>0.038</td>
<td>0.104</td>
<td>-0.011</td>
<td>0.005</td>
<td>0.113</td>
<td>-0.241</td>
</tr>
<tr>
<td>TotalI</td>
<td>-0.008</td>
<td>0.039</td>
<td>-0.005</td>
<td>-0.070</td>
<td>0.065</td>
<td>-0.298 **</td>
</tr>
</tbody>
</table>

*ClinicalExp: Years of clinical experience
GeneralExp: General computing experience
EHRExp: EHR-specific computing experience
NoEHRs: Number of EHRs used
* p < 0.1 (two-tailed)
** p < 0.05 (two-tailed)

A two-tailed t-test was used to look for significant differences in PU and I responses between the two clinical specialty categories (Surgery and Medicine) of respondents. No significant differences were found in AudPU, AudI, VidPU, VidI, TotalPU, or TotalI. However, respondents in surgical specialties had a significantly higher ImgPU ($M = 5.49, SD = 1.102$) than those in medical specialties ($M = 4.54, SD = 1.305$); $t(40) = 2.247, p = 0.031$. ImgI was also significantly higher for surgical specialties ($M = 5.692, SD = 0.947$) than medical specialties ($M = 4.593, SD = 1.563$), $t(40) = 2.753, p = 0.009$.

Another two-tailed t-test was performed to determine whether there were any significant differences in PU and I between male and female participants. Six of the dependent variables (ImgPU, ImgI, VidPU, VidI, TotalPU, and TotalI) did not show any significant difference between genders. AudPU was lower in males ($M = 3.56, SD = 1.628$) than females ($M = 4.33, SD = 1.547$), $t(40) = 2.247, p = 0.031$.
with borderline significance, \( t(40) = -1.654, p = 0.106 \). AudI was also lower in males (\( M = 3.61, SD = 1.712 \)) than females (\( M = 4.40, SD = 0.870 \)) with borderline significance, \( t(40) = -1.979, p = 0.055 \).

### 7.5 Relationships between Respondent Perceptions

Pearson correlations amongst the dependent variables were also calculated, as shown in Table 15. All of the dependent variables were correlated with each other. The strongest correlations were seen between PU and I for the same medium (image, audio, and video). The correlation between the combined PU variables (TotalPU) and the combined I variables (TotalI) was 0.933, highly significant at the \( p < 0.01 \) level (two-tailed).

#### Table 15

**Pearson Correlations between Respondent Perceptions**

<table>
<thead>
<tr>
<th></th>
<th>ImgPU</th>
<th>ImgI</th>
<th>AudPU</th>
<th>AudI</th>
<th>VidPU</th>
<th>VidI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ImgPU</td>
<td>1</td>
<td>.898</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ImgI</td>
<td>.898</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AudPU</td>
<td>.392*</td>
<td>.432**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AudI</td>
<td>.377*</td>
<td>.448**</td>
<td>.885**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VidPU</td>
<td>.361*</td>
<td>.437**</td>
<td>.547**</td>
<td>.503**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>VidI</td>
<td>.380*</td>
<td>.471**</td>
<td>.522**</td>
<td>.556**</td>
<td>.951**</td>
<td>1</td>
</tr>
</tbody>
</table>

** p < 0.05 (two-tailed)
*** p < 0.01 (two-tailed)

### 7.6 Linear Regression Analyses

Hierarchical linear regression analyses were performed to check the fit of the data to TAM and look for significant predictors of intention to use multimedia features. For each multimedia type (image, audio, video, and total), the independent variables and corresponding PU were input into the regression model. To avoid multicollinearity, age (correlated with years of clinical experience) and general computing experience (correlated with EHR-specific computing experience) were omitted from the regression. Number of EHRs used was also omitted. As
shown in Tables 16 through 19, PU accounted for a large portion of the variance in I (56.5 – 79.3%), confirming the PU-I relationship in TAM. None of the independent variables were strong predictors of I. In all four analyses, only model 4 (in which PU was added as a predictor) was significant. However, the borderline significance of specialty category in model 4 (for AudI, VidI, and TotalI) suggests that this relationship could become significant with a larger sample.

Table 16

Hierarchical Regression Predicting Intention to Use Image Features (ImgI)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 (ns)</th>
<th>Model 2 *</th>
<th>Model 3 (ns)</th>
<th>Model 4 **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.056</td>
<td>0.106</td>
<td>0.122</td>
<td>-0.016</td>
</tr>
<tr>
<td>Gender</td>
<td>0.097</td>
<td>0.153</td>
<td>0.129</td>
<td>0.024</td>
</tr>
<tr>
<td>Specialty category</td>
<td>-0.421 **</td>
<td>-0.485 **</td>
<td>-0.457 **</td>
<td>-0.021</td>
</tr>
<tr>
<td>EHR-specific experience</td>
<td>0.237</td>
<td>0.291</td>
<td>-0.143</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td>-0.129</td>
<td>-0.014</td>
<td></td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td></td>
<td></td>
<td></td>
<td>0.939 **</td>
</tr>
<tr>
<td>ΔF</td>
<td>2.242</td>
<td>2.144</td>
<td>0.510</td>
<td>122.888</td>
</tr>
<tr>
<td>ΔR²</td>
<td>0.161</td>
<td>0.050</td>
<td>0.012</td>
<td>0.616</td>
</tr>
<tr>
<td>Total R²</td>
<td>0.161</td>
<td>0.211</td>
<td>0.223</td>
<td>0.839</td>
</tr>
</tbody>
</table>

* = p < 0.1  
** = p < 0.05

For intention to use image features (ImgI; Table 16), only model 4 was significant, and PU accounted for 61.6% of the variance in ImgI. Model 2 showed borderline significance. Specialty category was significant in the first three non-significant models, with surgical specialties more likely to use images than medical specialties, but was no longer significant once PU was introduced in model 4.
### Table 17

*Hierarchical Regression Predicting Intention to Use Audio Features (AudI)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 (ns)</th>
<th>Model 2 (ns)</th>
<th>Model 3 (ns)</th>
<th>Model 4 **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.068</td>
<td>0.095</td>
<td>0.143</td>
<td>0.007</td>
</tr>
<tr>
<td>Gender</td>
<td>0.340 *</td>
<td>0.370 *</td>
<td>0.296</td>
<td>0.106</td>
</tr>
<tr>
<td>Specialty category</td>
<td>-0.226</td>
<td>-0.260</td>
<td>-0.172</td>
<td>-0.158 *</td>
</tr>
<tr>
<td>EHR-specific experience</td>
<td>0.124</td>
<td>0.294</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td>-0.401 **</td>
<td>-0.049</td>
<td></td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td></td>
<td></td>
<td></td>
<td>0.839 **</td>
</tr>
</tbody>
</table>

|                  |              |              |              |            |
| ΔF                | 1.328        | 0.524        | 4.944        | 88.635     |
| ΔR²                | 0.102        | 0.014        | 0.115        | 0.565      |
| Total R²           | 0.102        | 0.116        | 0.231        | 0.796      |

* = p < 0.1  
** = p < 0.05

Analysis for audio features (AudI; Table 17) showed that only model 4 was significant, with PU accounting for 56.5% of the variance in AudI. Gender showed a borderline significance in two non-significant models, with females being more likely to use audio features, but was not significant in the fourth model. Satisfaction was significant in the third model, which was non-significant overall, but was not significant in model 4. Specialty category did show borderline significance in model 4, with surgical specialties less likely to use audio features than medical ones.
Table 18

Hierarchical Regression Predicting Intention to Use Video Features (VidI)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 (ns)</th>
<th>Model 2 (ns)</th>
<th>Model 3 (ns)</th>
<th>Model 4 **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.010</td>
<td>-0.022</td>
<td>0.001</td>
<td>-0.047</td>
</tr>
<tr>
<td>Gender</td>
<td>0.261</td>
<td>0.226</td>
<td>0.191</td>
<td>0.077</td>
</tr>
<tr>
<td>Specialty category</td>
<td>-0.258</td>
<td>-0.218</td>
<td>-0.176</td>
<td>-0.102 *</td>
</tr>
<tr>
<td>EHR-specific experience</td>
<td>-0.148</td>
<td>-0.067</td>
<td>0.044</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>-0.192</td>
<td>-0.053</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td></td>
<td></td>
<td></td>
<td>0.931 **</td>
</tr>
<tr>
<td>ΔF</td>
<td>1.045</td>
<td>0.740</td>
<td>0.998</td>
<td>320.632</td>
</tr>
<tr>
<td>ΔR²</td>
<td>0.082</td>
<td>0.020</td>
<td>0.026</td>
<td>0.793</td>
</tr>
<tr>
<td>Total R²</td>
<td>0.082</td>
<td>0.102</td>
<td>0.128</td>
<td>0.921</td>
</tr>
</tbody>
</table>

* = p < 0.1  
** = p < 0.05

Intention to use video features (VidI; Table 18) indicated significance for model 4 only. PU accounted for 79.3% of the variance in model 4, while specialty category was borderline significant. None of the variables showed significance in any of the three non-significant models.

Table 19

Hierarchical Regression Predicting Intention to Use Any Multimedia Features (TotI)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 (ns)</th>
<th>Model 2 (ns)</th>
<th>Model 3 (ns)</th>
<th>Model 4 **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.054</td>
<td>0.070</td>
<td>0.106</td>
<td>-0.028</td>
</tr>
<tr>
<td>Gender</td>
<td>0.289</td>
<td>0.308</td>
<td>0.254</td>
<td>0.079</td>
</tr>
<tr>
<td>Specialty category</td>
<td>-0.369 **</td>
<td>-0.390 **</td>
<td>-0.326 *</td>
<td>-0.127 *</td>
</tr>
<tr>
<td>EHR-specific experience</td>
<td>-0.078</td>
<td></td>
<td>0.204</td>
<td>-0.026</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>-0.296</td>
<td></td>
<td>-0.033</td>
<td></td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td></td>
<td></td>
<td></td>
<td>0.894 **</td>
</tr>
<tr>
<td>ΔF</td>
<td>1.843</td>
<td>0.216</td>
<td>2.615</td>
<td>190.527</td>
</tr>
<tr>
<td>ΔR²</td>
<td>0.136</td>
<td>0.005</td>
<td>0.063</td>
<td>0.681</td>
</tr>
<tr>
<td>Total R²</td>
<td>0.136</td>
<td>0.142</td>
<td>0.205</td>
<td>0.886</td>
</tr>
</tbody>
</table>

* = p < 0.1  
** = p < 0.05
Analyzing the total intention to use any of the three types of multimedia features (TotalI; Table 19) resulted in only model 4 being significant, with PU accounting for 68.1% of the variance in TotalI. In this analysis, specialty category showed borderline significance in all four models, but with decreasing strength as more variables were added.

7.7 Qualitative Results

Of the 42 surveys collected, 13 had at least one open-ended question completed (25% of the sample). In total, 23 complete comments were collected, including two “see previous” comments that were excluded from analysis. Two independent reviewers analyzed the comments for recurring themes, and a consensus coding scheme was used to produce the final results (Table 20).

The comments from each of the three open-ended questions were compiled according to the modality, and then grouped by content category (attitudes, uses, and concerns). If a comment covered more than one content category, a relevant portion of the comment was included in each category.

Responses are summarized in Table 20. A respondent ID number is provided in square brackets at the end of each comment for linking responses throughout the table.
Table 20

Open-ended Responses Grouped by Content and Multimedia Type

<table>
<thead>
<tr>
<th>Multimedia type</th>
<th>Attitude</th>
<th>Potential uses</th>
<th>Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td>“I don't really understand what you are getting at.” [27]</td>
<td>“Would be helpful looking at progression of healing or from a complication. Could also provide a visual image of other pathologies not aware of.” [42]</td>
<td>“I am also concerned about time it would take to enter and use information unless it is organized in a coherent way.” [27]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“this is not likely relevant to my practice… of value to dermatology or something like that” [28]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“I do currently use a EHR with that feature… includes patient photo… to remind me of who the patient is” [21]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“This would be very useful as a geneticist!” [25]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“For my practice pictures of patients are not important.” [28] need access to pictures to perform job well [40]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not interested at all [31]</td>
<td>“recently bought a pen that will record voice and capture writing.” [28]</td>
<td>“we wouldn't have time to listen to [patient recordings]” [21]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“audio seems relevant to cardiology (e.g. murmurs), not to oncology.” [21]</td>
<td>“Would depend on how long the audio ‘bite’ features were.” [42]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“In a specialized practice [audio recordings] may not be that important.” [32]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“I cannot see any use of audio for my practice” [21]</td>
<td></td>
</tr>
<tr>
<td>Audio</td>
<td>“I wouldn't mind it” [21]</td>
<td>“Recording [movement disorder patient] symptoms in serial fashion will enhance assessment of treatment.” [35]</td>
<td>“all of this would be more time consuming” … “not sure that it would increase productivity!” [21]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“not especially relevant to my personal practice (oncology)” [21]</td>
<td>only if it does not take any effort to input or retrieve information [31]</td>
</tr>
<tr>
<td>Video</td>
<td>Very interested [31]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
“useful for teaching purposes” [37]

“Would depend on how long the video ‘bite’ was. Major problem [for audio and video] is that with present finding mechanism would be difficult to spend inordinate time viewing or listening to these ‘bites’ unless were very helpful.” [42]

“as a geneticist this would be extremely useful” [25]

Note. Comments are followed by a numerical respondent identifier in square brackets.

The content was also analyzed according to the positive or negative tone of the responses. Positive responses included attitudinal comments and positive remarks about potential or actual uses of multimedia (e.g. “useful for teaching”). Negative responses also included attitude, as well as concerns about the usefulness of multimedia (e.g. “not sure that it would increase productivity”). Of the 30 opinions expressed in Table 20, 15 can be categorized as positive, while 14 appear negative. This split in opinions echoes the quantitative survey results, where strong agreement and disagreement were recorded for the same individual questions (values of 1 and 7) but the average value for each type of multimedia was close to neutral.

Additionally, a high level of repetition was observed in the topics that respondents commented on. Eight comments noted potential or current uses of multimedia in their own practice, such as recording images of rashes or progressive symptoms (respondents 42 and 35 in Table 20). Two comments suggested that multimedia is better suited for teaching purposes than clinical care (respondents 27 and 37 in Table 20). There were four suggestions that multimedia features would be more useful for other clinicians than for themselves (e.g. “relevant to cardiology … not oncology [respondent’s own specialty]”).

There were five comments mentioning the increased time it would take to use multimedia information, and three concerned about increased effort to collect multimedia data. For example, video features were described as “time consuming” and difficult to search efficiently.
None of the respondents expressed the opinion that multimedia features were entirely irrelevant, deferring instead to other specialties and individual practice choices if they were not personally interested.

7.8 Summary of Physician Survey

Overall, physicians surveyed were evenly split between positive and negative perceptions of multimedia, based around potential applications and pragmatic concerns about non-textual information. As a group, there was slightly positive perceived usefulness and intention to use the features if they were implemented. The factor most strongly associated with PU and I was the respondent’s satisfaction with their current EHR system, with a significant negative correlation.
8.1 Creating Favourable Perceptions through Vendor Websites

The Internet is a popular information resource, and can be a useful tool for potential adopters who are gathering knowledge about a new innovation. Within the knowledge stage of Rogers’ innovation-decision model, potential adopters learn about an innovation from external sources of information. Vendor websites can be one source of information accessed by potential adopters considering buying an EHR system, and may be valued as a credible and accessible resource. Content types tended to be uniform across the sites, and trends that were seen in acute care sites were often also present in primary care sites.

Vendor websites can be used as tools to actively shape a wide range of perceptions about and create favourable attitudes towards a vendor and its specific products. Websites also reflect the importance that a vendor places on online communication and meeting information needs. A smoothly functioning, up-to-date website can indicate that a vendor is competent in maintaining online information. With the current focus on creating pan-Canadian EHRs (Infoway, 2007), a vendor’s familiarity with relevant online communication protocols and data standards will be critical in ensuring that EHRs can achieve nationwide integration.

Thoroughly meeting users’ information needs builds confidence in the ability of a vendor to provide both a satisfactory product and satisfactory customer service. For instance, the primary care EHR vendor websites in this study brought up the topic of converting existing paper records through scanning, but not the issue of entering the legacy data into the system in a machine analyzable format. Since this patient data is the purpose of maintaining records, not discussing existing data can present a major information gap for potential users. Similarly, acute care EHR vendor websites do not discuss end user support and training. While this is likely provided by all vendors, potential purchasers are not explicitly reassured that they will have assistance to transition end users (clinical and administrative staff), thus fostering long-term system sustainability and allowing institutions to benefit from their investment. Emphasizing support and training would reflect a service oriented approach, where customer support becomes a valuable resource alongside the original purchase.
In analyzing the vendor websites, we noted that some gaps exist in providing information via vendor-produced websites, namely:

- Lack of demos
- Lack of MM use for website features
- Favouring general information about EHR systems over product-specific information

A rich source of information that was mostly overlooked by vendors was the use of system demos. The exception is OSCAR, which was the only vendor to display both screenshots and video demos. Mock implementations are also accessible by request. Examples of the system interface provide users with evidence of the system’s functionality and usability that goes beyond text descriptions. Personal software in many domains is now offered in trial versions. These can be fully functional systems that operate for a limited time (e.g., SPSS, NVivo, Microsoft Office) or versions with partial functionality (e.g. Oligo, 2011). Based on Rogers’ concept of trialability, allowing users to experience the “feel” of the system and familiarize themselves with it can create positive perceptions and a comfort level that encourages adoption. This strategy has been employed by UHN in its own EHR training program, which allows staff to practice on a mock system anonymously so that they feel comfortable using it at work (UHN, 2011). Demos can also illustrate features that are difficult to accurately describe, such as visual integration of information on a screen layout. Particularly in the case of EHRs, where users need to trust the system to store critical patient information, trials and demos could be very important in convincing clinicians to adopt EHRs.

Even without demos, websites can send signals about a vendor’s comfort with managing data. Vendors wishing to shape perceptions about their systems could begin by mirroring those perceptions on their website. For example, the qualitative survey comments (section 7.7) indicated that physicians were concerned about being able to manage MM information (an example of PEOU). If a vendor website demonstrated an effective information management layout, it could create a perception of the vendor being capable of making a system allowing users to easily manage complex data, improving PEOU and encouraging acceptance. Many vendors in this study did not incorporate MM into their sites, but a trend towards MM may be emerging. Two vendors not listed in ITAC Health or OntarioMD during the data collection period, Allscripts and Purkinje|Dossier (Allscripts, 2011; Purkinje, 2011), have released video-intensive sites.
Existing strategies to create positive perceptions focus on customer testimonials and discussion of the benefits of any EHR system. Acute care vendors focused almost exclusively on text-based discussion of EHR benefits, such as how institutional integration leads to productivity gains. However, vendors did not directly claim that their product was capable of producing the desired benefits. By not clearly stating how a specific EHR system handles issues like security and privacy, potential clients are not able to compare systems and determine the best fit for their needs (described by diffusion of innovations as high compatibility). Additionally, primary care vendors provided more detailed product specifications than acute care vendors (section 6.4.1). These different strategies result in different amounts of information being offered between primary and acute care websites. This discrepancy also appears in the analysis of MM features (section 6.4.2). The lack of information provided on acute care vendor websites might represent a gap where users are not forming a range of positive perceptions, in turn lowering the probability of making an adoption decision.

Comparing the issues raised in the physician survey with the issues discussed by acute care EHR vendors on their websites revealed that physicians are interested in the clinical benefits of EHRs, while vendors tend to focus on institutional administration and integration. The ubiquity of the health information and administration components suggests that the main focus of primary care systems is ensuring that the internal functions of a practice are running smoothly. Additionally, the priority that both primary and acute care systems place on communication could reflect a focus on interoperability and integration deliverables. Communication functionalities also represent a very visible benefit of using electronic systems, facilitating automatic and instantaneous messaging between various people. Keeping a record of all communication also improves accountability in delivering care. The lack of patient support tools could potentially be explained by the existence of personal health records (PHRs), which are records owned by patients about themselves. PHR systems tied to EHRs, such as the MyOscar PHR (MyOscar, 2011), are well-placed to offer patients information and educational resources, instead of relying on physicians to be the sole source of clinical information.

One potential explanation for the overall lack of specific product information on vendor websites could be vendors’ competitive strategy. Vendors wishing to keep their rivals from knowing their system capabilities would be hesitant to reveal their system’s features on a public website. By limiting website information to general discussion of EHR benefits, vendors are able to create
positive perceptions about relative advantage (productivity, security, etc.) without giving away any sensitive information to competing vendors. This competitive strategy also explains the difference in the quantity of information provided between primary and acute care websites, since organizations interested in purchasing acute care systems likely follow an institutional procurement policy requiring the use of requests for proposals (RFPs) for vendors. Within the RFP system, potential adopters wait for vendors to present them with information, instead of independently seeking out information sources. In this situation, there is little advantage for acute care EHR vendors to display their systems on the Internet; instead, it becomes a major competitive disadvantage. Conversely, potential adopters of primary care EHRs are likely to be solo or small practice physicians, who are essentially purchasing personal software. Instead of issuing RFPs, primary care providers are expected to approach vendors and request information directly. Here, vendors have incentive to post public information about their systems, since it helps to make their product widely visible without needing extra resources to reach additional people. Although a competitive disadvantage to revealing information still exists for primary care EHRs, it is likely mitigated by the marketing benefits.

This explanation is supported by the finding that vendor websites only displayed some of the data that was available from OntarioMD, even though information on the OntarioMD site is supplied by the vendors themselves. OntarioMD provided information that was more detailed and specific to implementation than the vendor sites, and also gathered a consistent dataset from all vendors to facilitate comparisons. OntarioMD seems to be functioning as an impartial third party, giving it credibility as an information source, while educating physicians about what they need to be looking for in a system. One of the most notable examples of information that is highlighted in OntarioMD but not on vendor websites is whether the system has been licensed by Health Canada. Regulations for licensing EHR systems as medical devices have been put into place (Health Canada, 2011), giving users an external measure of credibility they can use to assess systems, but only if they know that it exists.

Based on this analysis of the knowledge stage of EHR diffusion, it seems that a lack of access to concrete information about EHR systems could present a barrier to diffusion. Finding methods to reduce or eliminate this barrier could be one strategy to encourage EHR diffusion and acceptance, allowing potential users to move from the knowledge stage into the persuasion stage.
8.2 MMEHR Diffusion and Implementation

In the persuasion stage of the innovation-decision process, potential adopters use the information they have gathered about an innovation to form perceptions about the innovation and whether they should adopt or reject it. Using a TAM survey to elicit perceptions about MMEHRs, it was found that there was little overall interest in adopting clinical MM features. As hospital-based clinicians, some of the major external barriers to potential adoption were mitigated, such as financial costs associated with adding new system features or a lack of technical support (Gans et al., 2005; Jha et al., 2009). This encouraged respondents to focus on personal preferences in explaining their support or rejection of the proposed MM features. Many comments described the potential impact on their practice or specialty (e.g., genetics or neurology), while acknowledging that a variety of practice styles exist. This could suggest that unanimous support for multimedia features is not likely to occur.

While clinicians were able to imagine some benefits of using MM features (and some clinicians have already adopted certain MM independently), they were also concerned about being able to manage MM data and incorporate this new type of information into their workflow. Positive comments focused on the ability of MM to enhance existing tasks (e.g. teaching); alternatively, negative comments focused on expected changes in creating and using clinical data. Respondents did not seem to be interested in disruptive technologies that could change their daily workflow (possibly due to fears of losing information or current productivity levels); this ties in with the finding that satisfaction was negatively related to intention to use MM features. This can provide some insight into the issues relevant to physicians, and perhaps insight into the knowledge that forms their perceptions as well. For example, concerns about increased time and effort showed their awareness that recording MM information could easily lead to information overload. If these concerns are based on prior experience with MM (perhaps through experience with personal camcorders or digital cameras) showing that MM data was difficult and time-consuming to retrieve, these concerns could be alleviated by allowing clinicians to experience an efficient MM search tool and convince themselves that it is feasible to be productive using clinical MM.
Often, HIT studies use TAM to evaluate a system that has already been deployed or presented to users as a trial, such as in Liu & Ma (2005), Lin & Yang (2009), and Aggelidis & Chatzoglou (2009). In this study, the TAM survey gauging perceptions of and intention to use MMEHRs was deployed prospectively, before MM features were actually implemented in an EHR system.

The physician survey implemented TAM prospectively, surveying users’ perceptions before they had received any exposure to the proposed features. Analyzing the resulting data showed that the PU-I relationship was still present, indicating that TAM can be used as an upstream instrument to measure PU-I without needing a trial or mockup of the technology. Using TAM in the pre-implementation stage provides a potential tool for minimizing EHR rejection. By eliciting positive and negative perceptions before introducing the system to the users, negative attitudes can be identified and targeted with the additional knowledge needed to form positive perceptions. In the example given above (the opportunity to use an efficient MM search tool), physicians are encouraged to accept MM based on positive experiences with MM searching. TAM can also provide software developers with user feedback in the early stages of software development, allowing them to create useful and relevant features that are more likely to be successfully adopted by end users. Filling out the TAM survey is also quick enough to be practical in the healthcare sector, which is known to have little patience for extensive or complex questionnaires (see sections 2.4.2, 5.3.5 on survey response rate).

Existing studies using TAM and diffusion of innovations for EHRs show general agreement with our work, which found no significant physician characteristics predicting PU or I. A similar study by Morton & Wiedenbeck (2009) found that the PU-I relationship was still significant for physicians who were planning to implement EHR systems, which coincides with our results. They also found that demographic characteristics were not related to attitudes (namely age, years in practice, clinical specialty, and prior computer use). This corresponds with a number of other studies that found no effect of gender or age on perceived usefulness of HIT (Dansky et al., 1999; Ernstmann et al., 2009; Schectman et al., 2005). Although Dansky et al. (1999) observed a correlation between general computer expertise and PU for EMRs, our analysis suggests that this relationship may not be significant for MMEHRs. In our study, only EHR expertise and satisfaction were correlated with any of the PU and I variables. This suggests that perceptions are not related to demographics and other stable variables, but to personal experience with similar technologies. Additionally, our finding that EHR-specific expertise does not predict variance in I
is corroborated by Wiggins et al., who found that having EMR training in residency does not predict intention to use EMRs in clinical practice (2009).

Researchers who applied diffusion of innovations theory to EHR systems found that end users attributed high relative advantage to EHRs both during and after implementation (Bower, 2005; Griever, 2010). We observed similar attitudes in our pre-implementation survey, receiving a sizeable number of positive comments on potential uses for MM features. This is also reflected in the academic literature, with physicians and other experts noting how medical care could be improved with MM data (IOM, 2003; Lowe, 1999; Shachak & Jadad, 2010). The comments also highlighted user resistance due to changes in workflow, a phenomenon documented in other studies of EHR implementations (Connolly, 2005; Lapointe & Rivard, 2005; Tjora & Scambler, 2009). We noted an inverse correlation between user satisfaction and intention to use MM features, which can also be interpreted as resistance to workflow changes. Conversely, this finding also suggests that the more satisfied a respondent is with their current EHR, the less likely they are to desire new multimedia features. Resisting specific components of a system is important for EHR systems, which are often rolled out in phases (Anderson, 2009; Lapointe & Rivard, 2005), and more research into how satisfaction with existing systems can affect intention to use upgrades is warranted.

For MMEHR developers, the main finding of this study is that there is currently little demand from end users for multimedia (MM) features. This is reflected in the vendor websites, which do not emphasize MM features in their systems. Some websites do not present any MM features, possibly implying that the system does not have any MM capabilities, or that MM features are present but are not considered important enough to be mentioned on the website. This suggests that it is not a priority for the vendors and that perhaps MMEHR diffusion is occurring at very low levels or not at all.

From the physician's standpoint, MM is an untested set of features that does not show immediate and clear benefits. Their primary concerns, as shown in the qualitative survey comments, focus around productivity and efficiency, implying that major improvements in organization and retrieval of MM data are needed in order for MM to be a viable feature. Potential uses for MM can be generally categorized as enhancements for existing practice (such as creating training materials), not as disruptive innovations; features designed to radically alter clinical workflow
may be less readily adopted. For all system components, any level of practice change is likely to result in incomplete adoption or even resistance, so MM should not be implemented as an essential part of a patient record.

Although we did not explicitly apply MST in this study, the survey comments collected suggest that physicians evaluate MM features based on the tasks required to provide patient care. This task-centred perspective seems to match the MST premise categorizing media based on their ability to support conveyance or convergence tasks (Dennis et al., 2008). MST may be a useful model for future research examining MMEHR usage patterns by physicians and other clinicians.

### 8.3 Limitations and Future Research

Using vendor websites as a primary information source presents some difficulties in collecting data for analysis. Websites can be updated frequently and at any time, so the analysis can only reflect information presented on the websites during the data collection period (Bar-Ilan & Peritz, 2009). Not having a standard framework for website content evaluation also meant that an ad hoc scheme for comparing sites had to be constructed; therefore, a grounded theory-like approach was applied. Most sites were uniform enough that categories could be generated from the raw data. The analysis of system feature information may be incomplete due to missing information on websites. Additionally, some EHR vendors in Ontario may not have been included in the analysis if they were not listed in either ITAC Health or OntarioMD. Since there is no registry of all primary and acute care vendors, using these two sources was considered the most reliable and efficient method of locating vendors. Both organizations provide independent validation that the vendor is currently active in Canada or Ontario. Despite these limitations, the vendor website analysis reveals important information about using websites as an information source.

Efforts to mitigate the limitations of this study create new opportunities and challenges for researchers by identifying additional gaps in our knowledge. For example, we have found that EHR vendor websites do not provide much detail about their EHR systems. Further studies could focus on contacting vendors with the purpose of:

- obtaining comprehensive system information (e.g. through documentation, demos, trials, or interviews),
- comparing website system information with the actual product features,
- determining their website strategy and finding out why comprehensive information and demos are not publicly available,
- understanding EHR system procurement processes, or
- soliciting opinions on MM feasibility, importance, and the future of EHRs.

The vendor website analysis also revealed that academic study of informational website components seems to be an uncommon topic, and one usually approached without the benefit of a theoretically grounded framework. As online information becomes an increasingly important information source, a methodology for evaluating websites would be a useful tool for researchers.

One difficulty in using TAM to study system features that have not yet been implemented is the need to describe the technology in the survey. The original application of TAM was to systems that users had some prior experience with (Davis, 1989). In this case, responses were based not on exposure to an existing system, but on a brief textual description and respondents’ prior knowledge of multimedia. Providing study participants with a mockup or a preliminary version of the features would allow all responses to be based on a more concrete experience. Another major limitation of the physician survey is the small sample size. Although a 30% response rate is not unusual for physician survey research and TAM studies (Chang et al., 2007; Chau & Hu, 2002), obtaining data from a larger sample of the study population would allow conclusions to be drawn more confidently and reduce the possibility of Type II error (false negative) due to a small sample size. In this study, the target population was also quite small; expanding the population to include all UHN physicians would have provided more raw data for analysis, even if the overall response rate remained low. Investigation into potential confounders showed that all but one of the females in the sample who declared a clinical specialty were classified as medical specialists, while the male proportion of the sample was split nearly equally between surgical (12 responses) and medical specialties (14 responses). This unevenly distributed sample could affect the data analysis.

The physician survey presents a different set of research opportunities. The low response rate typical of physician surveys could become a topic of study of its own, exploring different data collection methods and incentives as a means of encouraging participation. For example,
research on incentives suggests that a small monetary payment can significantly increase response rates (Edwards et al., 2009; VanGeest, Johnson, & Welch, 2007; Zanganeh et al., 2008). A more standard application of TAM could be implemented with a prototype of the proposed MM features, potentially helping respondents provide more specific feedback. Additionally, this study could be used as the starting point for a longitudinal study examining changes in user perceptions over the course of implementing MM features, if the developers of the UHN EHR ever decided to integrate additional MM into their system.

8.4 Conclusion

This exploratory study examined the acceptability of MM features in EHRs from the perspectives of vendors and physicians. Vendors did not emphasize MM development for their systems, and physicians did not show much interest in using them in their practices.

Websites produced by vendors of commercial EHR systems did not provide detailed or comprehensive information about their products. Many vendors did not integrate MM data into their websites, and little mention was made of MM functionalities or compatible hardware to support non-textual data entry. If existing systems are not equipped to handle non-textual data, a shift towards MM enhancement of EHRs will not be feasible, in terms of both technology and practice.

Eight external factors (age, gender, clinical specialty, years of clinical experience, general computing expertise, EHR-specific experience, number of EHR systems used, and satisfaction with current EHR system) were analyzed in the physician survey. None of these were predictors of physicians’ perceived usefulness of or intent to use MM in EHRs. Physician responses were slightly positive towards image and video EHR features, and slightly negative towards audio features. Physicians in surgical specialties were also more favourable towards image features than medical specialists. MM could be an incentive to adoption, provided that it is implemented well. In order for MM to be viewed as a viable data source, it needs to be augmented with fast and user-friendly storage, search, and retrieval mechanisms.

Based on diffusion theory, we suggest that a lack of product-specific information from vendors could be a barrier to physician adoption of EHRs. An increase in relevant and product-specific
information on vendor websites would serve to better educate potential clients about the competitive strengths of various EHR products. The lack of evidence to support claims of efficiency and productivity can cast doubt on the truth of these claims. Users do not move from knowledge to persuasion in the innovation-decision process without gathering what they feel is enough information about the innovation under consideration. Vendors can be one of the information sources users turn to, if they provide enough useful information to establish them as a credible participant in the discussion surrounding adoption.
References


Appendices

Appendix A: Vendor Website Analysis Data Collection Form

Review Date & Name:

<table>
<thead>
<tr>
<th>Vendor Name</th>
<th>Vendor Homepage URL</th>
<th>ITAC/ONMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Name</td>
<td>System Homepage URL</td>
<td>Primary/Acute Care</td>
</tr>
</tbody>
</table>

**Section 1: General Website Analysis** (publicly accessible information only)

<table>
<thead>
<tr>
<th>Date Last Modified, Data Source</th>
<th>Target Audience(s) (e.g. public, MDs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor has offices in Canada?</td>
<td>Search functionality Non-English site available?</td>
</tr>
</tbody>
</table>

A. Findability: Description of route from vendor homepage to system homepage *(include multiple options if found)*

B. Navigation *(ease of navigation and backtracking, staying oriented within site)*

C. External credibility *(endorsements/testimonials, client list, HONcode, association logos)*

D. Aesthetics *(e.g. readability, consistent visual style and layout, overall design, language appropriate for audience)*

E. Use of graphical/multimedia features on site; does not have to be related to system *(attach sample with corresponding URLs)*

F. Screenshot of homepage

**Section 2: General System Analysis**

<table>
<thead>
<tr>
<th>Date Last Modified, Data Source</th>
<th>Target Audience(s) of system (e.g. oncology hospitals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor’s main/secondary product?</td>
<td>Target Audience(s) of information about system</td>
</tr>
</tbody>
</table>

A. Feature list (include languages available, connection to external resources, quotes of “user-friendly interface” etc.)

B. Non-textual description of features
   B1. Screenshots of system interface *(attach corresponding URL)*
   B2. Video/animated system demonstrations
B3. Use of other graphical/multimedia features to describe system *(attach sample)*

C. Hardware, software, other technical requirements

D. System clients
   D1. Known location of client base (e.g. Ontario, Canada, not stated)
   D2. Client list/testimonials for this system only *(see also 1C)*
   D3. Customer support services *(contact information, members-only pages, etc.)*

E. Is other information about the system available? (development history, compliance with standards, etc.)

F. Screenshot of homepage

**Section 3: Multimedia System Features**
*Quote specific capabilities or attach samples of non-textual information.*

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image (incl. diagnostic images, scanned forms)</td>
<td></td>
</tr>
<tr>
<td>Audio (incl. dictation)</td>
<td></td>
</tr>
<tr>
<td>Video</td>
<td></td>
</tr>
<tr>
<td>Tablet input, handwriting recognition</td>
<td></td>
</tr>
<tr>
<td>Graphing or plotting data</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

Other information:
Appendix B: Recruitment Email Texts

(sent by Leon Lem on behalf of Natalie Yeung and the research team)

Initial Recruitment Email
Subject: Invitation to participate in a study of multimedia EHR features

Hello,

You are cordially invited to participate in a research study examining health professionals’ perceptions of multimedia features in electronic health record (EHR) systems. The results of this study will provide valuable information for future EHR system development.

The research is part of a Master’s thesis conducted at the Faculty of Information, University of Toronto under the supervision of Dr. Aviv Shachak (Ph.D., Assistant Professor, Faculty of Information and Dept. Health Policy, Management and Evaluation) in collaboration with researchers from UHN (Prof. Alex Jadad and the telehealth program).

Participation involves filling in a single online survey that is expected to take less than 15 minutes to complete. Compensation will not be provided.

If you are interested in participating, please click on the link below to learn more and access the survey: (web survey link)

The survey will be available between DATE and DATE, 2010.

If you have further questions, please feel free to contact myself or Dr. Shachak (phone: 416-978-0998, e-mail: aviv.shachak@utoronto.ca).

Thank you, and have a nice day!

On behalf of the research team,

Leon Lem, RN BScN CNCC
(contact information)

Natalie Yeung
(contact information)
Recruitment Reminder Email

Subject: Reminder: Invitation to participate in a study of multimedia EHR features

Hello,

This is a follow-up reminder about an invitation, sent to you on DATE, to participate in a research study examining health professionals’ perceptions of multimedia features in electronic health record (EHR) systems. The results will provide valuable information for future EHR system development.

If you have already participated in this study, thank you very much for your time and input, and please ignore this message.

The research is part of a Master’s thesis conducted at the Faculty of Information, University of Toronto under the supervision of Dr. Aviv Shachak (Ph.D., Assistant Professor, Faculty of Information and Dept. Health Policy, Management and Evaluation) in collaboration with researchers from UHN (Prof. Alex Jadad and the telehealth program).

You are cordially invited to participate during the next two weeks while the study is being conducted. Participation involves filling in a single online survey that is expected to take less than 15 minutes to complete. Compensation will not be provided.

If you are interested in participating, please click on the link below to learn more and access the survey: (web survey link)

The survey will be available until DATE, 2010.

If you have further questions, please feel free to contact myself or Dr. Shachak (phone: 416-978-0998, e-mail: aviv.shachak@utoronto.ca).

Thank you, and have a nice day!

Leon Lem, RN BScN CNCC
(contact information)

Natalie Yeung
(contact information)
Appendix C: Informed Consent and Questionnaire

Survey: User Perceptions of Electronic Health Record (EHR) Features

Investigators
Natalie Yeung – Faculty of Information, University of Toronto (primary contact)
Email: natalie.yeung@utoronto.ca
Prof. Aviv Shachak – Faculty of Information, University of Toronto
Email: aviv.shachak@utoronto.ca
Office: 416-978-0998
Dr. Alejandro Jadad – Centre for Global eHealth Innovation, University Health Network
Mr. Leon Lem – Centre for Global eHealth Innovation, University Health Network

Study Description and Informed Consent Statement

Introduction
Thank you for your interest in this research study! Your time and input are valuable to us.

This study is being undertaken by investigators from the University of Toronto and the University Health Network (UHN) as part of a Master's thesis. We are interested in assessing the perceptions of physicians regarding electronic health record (EHR) systems with multimedia features for documenting patient encounters. These features incorporate still images, audio, or video recordings generated during a clinical encounter into a patient’s EHR. The results of this study will assist in improving the usefulness of EHRs, leading to more effective patient care and increased quality of service.

Study Method
As a UHN physician, you are invited to voluntarily participate in this study by completing the following survey once. The survey consists of 32 questions regarding general personal characteristics and your opinions on potential EHR features, and is estimated to take less than 15 minutes to complete. You may omit any questions that you do not wish to answer.

Confidentiality
In order to protect your confidentiality, personally identifying information will not be collected (such as names or employee numbers). Only investigators will have access to your survey. Results will only be reported in aggregate form, minimizing the potential of identifying individuals based on unique demographic characteristics.

Risks
Participating in this study carries a minimal risk of harm, as it does not involve any intervention and is intended to learn about your perceptions of the proposed information system features. You may freely withdraw from the survey at any time. There is no risk of being linked to your responses.

Benefits
No immediate personal compensation will be provided. Indirect benefits include being able to contribute to discussions of user needs in EHR system development, eventually impacting clinical practice and the quality of patient care.
Questions
If you have any questions, concerns or would like to speak to the study team for any reason, please contact them using the information at the beginning of this document.

If you have any questions about your rights as a research participant or have concerns about this study, call Ronald Heslegrave, Ph.D., Chair of the University Health Network Research Ethics Board (REB) or the Research Ethics office at 416-946-4438. The REB is a group of people who oversee the ethical conduct of research studies. These people are not part of the study team. Everything that you discuss will be kept confidential.

Informed Consent
This study has been explained to me and any questions I had have been answered. I know that I may leave the study at any time. I understand that returning this survey to the investigators implies that I am giving my consent to participate in this study.
Questionnaire Items

Section 1 of 5: Personal Characteristics

1. Age (please enter in years): __________

2. Gender: __________

3. Clinical Specialty
   Please select the option that most closely matches your PRIMARY clinical specialty from the following list:
   
   - Cardiac Surgery
   - Dermatology
   - Emergency Medicine
   - General Surgery
   - Internal Medicine
   - Medical Genetics
   - Neurology
   - Neurosurgery
   - Ophthalmology
   - Orthopedic Surgery
   - Otolaryngology — Head and Neck Surgery
   - Physical Medicine and Rehabilitation
   - Plastic Surgery
   - Psychiatry
   - Urology
   - Other (please specify): ______________

4. Number of years in clinical practice: ______________
Section 2 of 5: Experience with Computer Systems

5. I would rate my level of expertise in general computing (e.g. e-mail, word processing, etc.) as:
   __ Novice
   __ Advanced beginner
   __ Competent
   __ Proficient
   __ Expert

6. I would rate my level of expertise in using electronic health record (EHR) systems as:
   __ Novice
   __ Advanced beginner
   __ Competent
   __ Proficient
   __ Expert

7. Number of EHR systems I have used: ______________
   (Please include all computerized systems used for documenting patient information in inpatient or ambulatory care.)

8. Overall, I am satisfied with my current EHR system.
   __ Strongly dissatisfied
   __ Dissatisfied
   __ Neither dissatisfied nor satisfied
   __ Satisfied
   __ Strongly satisfied
   __ Not applicable
Section 3 of 5: EHRs with Still Image Features

Description of Proposed Feature

The following statements refer to a system that incorporates clinically relevant still images into an EHR. This does not include currently existing features such as diagnostic images (e.g. radiology, pathology, etc.). Instead, it refers to the ability to take and view images of any interesting findings resulting from a patient encounter (such as general appearance or affect, wounds, lesions, infections, etc.).

Please rate your level of agreement with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Using an EHR system with this feature would improve my performance in clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>10. Using EHR systems with image features in my clinical practice would increase my productivity.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>11. Using EHR systems with image features would enhance my effectiveness in clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>12. I would not find EHR systems with image features useful in my clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>13. I would use EHR systems with image features in my clinical practice whenever possible.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>14. Given a choice, I would prefer not to use EHR systems with image features in any part of my future clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>15. I would prefer to use EHR systems with image features in all parts of my future clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

16. Please provide comments on this scenario (optional):
Section 4 of 5: EHRs with Audio Features

Description of Proposed Feature

The following statements refer to a system that incorporates clinically relevant audio recordings into an EHR. This does not include currently existing features such as clinician dictation. Instead, it refers to recordings generated during a patient encounter (such as patient monologues, conversations with patients, or clinical sounds).

Please rate your level of agreement with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. Using an EHR system with this feature would improve my <em>performance</em> in clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>18. Using EHR systems with audio features in my clinical practice would increase my <em>productivity</em>.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>19. Using EHR systems with audio features would enhance my <em>effectiveness</em> in clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>20. I would <em>not</em> find EHR systems with audio features useful in my clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>21. I would use EHR systems with audio features in my clinical practice whenever possible.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>22. Given a choice, I would prefer <em>not</em> to use EHR systems with audio features in any part of my future clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>23. I would prefer to use EHR systems with audio features in all parts of my future clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

24. Please provide comments on this scenario (optional):
Section 5 of 5: EHRs with Video Features

Description of Proposed Feature

The following statements refer to a system that incorporates clinically relevant video recordings into an EHR. This is not restricted to patient-focused educational videos, but can include part or all of the interaction with a patient or diagnostic video recordings. For the purpose of this survey, assume that it is possible to easily retrieve the whole video or just short segments that are of interest.

Please rate your level of agreement with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>25. Using an EHR system with this feature would improve my <em>performance</em> in clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>26. Using EHR systems with video features in my clinical practice would increase my <em>productivity</em>.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>27. Using EHR systems with video features would enhance my <em>effectiveness</em> in clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>28. I would <em>not</em> find EHR systems with video features useful in my clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>29. I would use EHR systems with video features in my clinical practice whenever possible.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>30. Given a choice, I would prefer <em>not</em> to use EHR systems with video features in any part of my future clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>31. I would prefer to use EHR systems with video features in all parts of my future clinical practice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

32. Please provide comments on this scenario (optional):

Thank you for participating in this research study! Your time and input are very much appreciated.