ELECTRONIC MEDICAL RECORDS INTERFACE DESIGN CONSIDERATIONS FOR IMPROVING OUTCOMES FOR DIABETES MANAGEMENT IN PRIMARY CARE: A USABILITY STUDY

Electronic Medical Records Interface Design Considerations for Improving Outcomes for Diabetes Management in Primary Care: A Usability Study

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ABSTRACT

Efficient strategies for diabetes management in primary care provide avenues through which the disease may be monitored and controlled, but systems and processes must be more than adequate. The use of Electronic Medical Record systems (EMRs) assist healthcare providers in delivering quality care to patients to help better manage chronic conditions, and integrate services throughout the healthcare system so that relevant chronic disease programs may be made available to individuals and communities. Usability issues have often been blamed for poor EMR adoption rates, underutilization of systems, endangerment of patient health and inadequacies in providing positive health outcomes for patients while improving the quality of chronic disease management.

This thesis investigates the use of EMRs in managing diabetes within primary care, and evaluates their usability and its effects in managing diabetes in patients, with special reference to patient safety, health care provider workflow and adherence to clinical practice guidelines (CPGs).

Existing evidence emphasizing the management of diabetes and the role of the EMR in primary care is presented, while three levels of usability and several usability guidelines are identified and investigated. Data gathered from the local environment, show the relationships between EMR usability, patient safety, clinician workflow and adherence to CPGs in managing diabetes, and three models of EMR usability are suggested.

The primary proposition for this study is that EMRs provide promise in helping to control diabetes in patients. However EMR usability may present significant hindrances in

maximizing outcomes for individuals and in providing support programs and services to communities.

Keywords:
Diabetes, Electronic Medical Records (EMRs), Family Physician, General Practitioner, Primary Care, Usability, Workflow

GLOSSARY

In this paper, “Electronic Medical Record system” or “EMR” refers to a computerized provider in-office information system that allows for ordering, storage, retrieval and modification of patients’ demographic and medical / clinical information for the purpose of delivering [medical] care.

“Primary care” refers to the first point of contact for most persons seeking health care services, and is generally the place for continued care within the health care system.

The term “primary care physician” may be used synonymously with terms such as “family physician” and “general practitioner”. Other types of physician specialties will be specified as they appear.

The term “chronic disease” may be used synonymously with the terms “chronic conditions”, “non-communicable diseases” and “non-communicable conditions”, and refers to those ailments and/or conditions that are acknowledged as being of long duration and slow progression over time.

The chronic condition “Diabetes Mellitus” will be referred to as “Diabetes”.

The term “Type 1 Diabetes” may be used synonymously with the term “Type I Diabetes”.

The term “Type 2 Diabetes” may be used synonymously with the term “Type II Diabetes”.

LIST OF ABBREVIATIONS

CDA	Canadian Diabetes Association
CDM	Chronic Disease Module
CDPM	Chronic Disease Prevention and Management
CPG	Clinical Practice Guideline
DHC team	Diabetes Health Care team
EMR	Electronic Medical Record system
ICD	International Classification of Disease
ISO	International Organization for Standardization / International Standards Organization
LHIN	Local Health Integration Network
MoHLTC	Ministry of Health and Long Term Care
OHIP	Ontario Health Insurance Plan
SNOMED	Systematized Nomenclature of Medicine

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1. INTRODUCTION

In order to maintain adequate blood glucose levels that help prevent and treat complications associated with diabetes, close monitoring of the disease is paramount. Efficient strategies for diabetes management in primary care provide avenues through which the disease can be monitored and controlled, but systems and processes must be more than adequate.

One such strategy is the use of Electronic Medical Record systems (EMRs) which assist healthcare providers in delivering quality care to patients to help better manage chronic conditions, and in integrating services throughout the healthcare system so that relevant chronic disease programs can be made available to individuals and communities.

In general, widespread adoption of EMRs within the primary care system in Canada has been slow, and among those who have adopted systems from various vendors, there have been complaints that application interface, design and usability hinder the effective management of chronic disease in individuals and communities. Although there are many different factors affecting application usability (the ease with which an interface can be used) it is often underestimated, and is one of the least served areas in EMR design.

The objectives of this study are to investigate the use of EMRs in managing diabetes within primary care in Canada, and to evaluate their usability, with special reference to health care provider workflow, adherence to clinical practice guidelines (CPGs) and patient safety in managing diabetes in individuals.

The analysis of several information sources includes (but is not limited to) the effect of EMR deficiencies on adoption rates, the success of diabetes management for individuals and the availability of support programs for persons with diabetes.

The benefits and beneficiaries of this study are several, but the stakeholders who stand to benefit the most are individuals living with diabetes. Although this usability study may be applied to the management of many chronic diseases in primary care, further research will be required to identify deficiencies in the management of specific chronic conditions for which care guidelines are not as clearly delineated as that of diabetes.

The dissertation proceeds as follows. First, a scan of the primary care environment is presented which sets the stage for a literature review of existing evidence on EMR usability and clinical diabetes care workflows. The data collection methodology is next, followed by an analysis of the data and presentation of the results of the study. The discussion and interpretation of results precedes the conclusions which are drawn from both a research and user perspective.

This study questions and procedures were reviewed by and received clearance from the McMaster University Research Ethics Board in Hamilton, Ontario Canada (Appendix A).

1.1 Research Question:

Should EMR usability within primary care be considered a significant dynamic in the effective management of diabetes in individuals?

2. ENVIRONMENTAL SCAN

2.1. Overview of Primary Care in Ontario

Primary care encompasses a wide range of health care services that focus on preventing, diagnosing and treating many health related conditions, and is usually the first point of contact people have with the health care system in Canada [1]. It is also usually the avenue through which people access continued health care and the coordination of other care services not provided by a family physician. Because of the many varied services provided by primary care, the circle of care available to a patient includes not only family physicians and nurses, but also dietitians, mental health professionals, pharmacists, social workers and other health care providers including pediatricians, obstetricians and gynecologists. In Ontario, those emergency and primary care services deemed "medically necessary" are funded by the Ontario Health Insurance Plan (OHIP), and provided to residents free of charge.

According to a 2009 Ontario Physician Human Resources Data Centre report, there are over 11,000 active family physicians in Ontario [10]. Family physicians are the main providers of health care services in the province and are at the centre of the health care system, forming the foundation for primary care [2]. Family physicians in Ontario utilize a range of compensation models and payment methods. Within primary care, the Fee-For-Service model is the most widely used by those working alone in private practice, while the Alternative Payment Plan is typically used by those practicing in groups. Within the APP model, a physician may receive compensation via salary or capitation (receiving a set amount for each rostered patient) or a combination of the two methods [2]. Percentages of family physicians by remuneration model for Ontario are presented in Appendix B.

Not to be confused with primary health care (the conceptual model that includes processes of income, housing, education and environment [11] that outline the framework for health care delivery, and that focuses on comprehensiveness of care with regard to prevention of illness, health promotion, community development and population health [3]) primary care focuses on family physician services provided to the individual such as diagnosis and treatment of illness, health promotion and prevention of illness and injury [5], and is intended to provide continuous care throughout one's lifetime. Although a sub-component of primary health care, primary care's comprehensiveness is not guaranteed, and may be limited by factors such as the range of environments that one's family physician may operate in. While a patient may at times require emergency care, surgery or other admission to a hospital, nursing home and/or palliative care, many family physicians practice exclusively from their offices, limiting the comprehensiveness of care that PHC is intended to provided [4].

Strategic direction in the primary care system in Ontario is provided by the Ministry of Health and Long Term Care (MoHLTC), through the establishment of priorities, development of legislation standards and policies, surveillance of population health and the management of funding models [8]. To improve the delivery of health care in the province, the MoHLTC has mandated that accountability in primary care be demonstrated through comprehensive reporting of activities that increase Ontarians' access to health care professionals and of activities that reduce wait times for health care services [5]. These patient centered activities include the creation of Community Health Centres [12] and inter-professional Family Health Teams, the provision of employment for new Ontario nursing graduates and the accessibility to internationally trained health professionals [5].

In 2006, in order to assess and manage the health service needs and priorities of communities in the province, the MoHLTC launched 14 not-for-profit Local Health Integration Networks (LHINs), each with a mandate to develop integrated health service

plans for each of 14 geographic regions [9]. Each LHIN is governed by a Board of Directors, and their Annual Service Plans and Accountability Agreements with the MoHLTC detail performance goals, metrics and budgets [5]. Appendix C outlines the coverage of each LHIN in Ontario and also provides information on further reading about each LHIN's Accountability Agreement and Annual Service Plan.

In an effort to achieve transformational change by addressing and encouraging comprehensive health care in the province, the MoHLTC has provided funds for several projects aimed at primary care renewal/reform [5]. As a result, there has been the development of primary care models that focus on delivering appropriate care through the use of multi-disciplinary teams of health care professionals and the use of quality improvement programs [40]. These multi-disciplinary teams also facilitate the coordination of care with other health services [12]. Additionally, models have been developed for chronic disease management, health promotion, illness and injury prevention and 24/7 access to essential services [12]. According to *HealthForceOntario*, there are 10 models of primary care delivery in Ontario, all focused on the efficient use of health care resources and the provision and improvement of accessible quality health care, through the optimization of multi-disciplinary health care teams, information technology and care guidelines [6]. Appendix D provides an overview of the main components of each primary care delivery model in Ontario.

2.2. Chronic Disease Prevention and Management in Primary Care

Non-communicable diseases and conditions that are acknowledged as being of long duration and slow progression over time are categorized as chronic diseases. These ailments are generally characterized by multiple risk factors - both proximal and distal – as well as functional impairment and/or disability. Although the risk factors may be adequately controlled through modifications in lifestyle and / or environment, very rarely are they ever completely cured [15].

A 2010 World Health Organization (WHO) report on the status of non-communicable diseases globally, identifies chronic diseases as the leading causes of morbidity and mortality world-wide, accounting for more deaths annually than all other causes of death combined [18]. In Canada, disability and deaths associated with chronic diseases is very much like the global picture and the economic burden is tremendous. With current trends, it is estimated that by 2020, Canada will lose billions of dollars from premature deaths associated with chronic diseases [20].

In 2003, the Canadian Community Health Survey estimated that among Ontarians over age 45, about 80% of them were living with a chronic disease, while almost three-quarter of chronic disease sufferers battle two or more of these ailments [19]. However, ironically, the 2006 *Commonwealth Fund International Health Policy Survey of Primary Care Physicians* revealed that among seven (7) developed countries, Canada ranked last overall in measuring and managing chronic disease prevention and management activities, as well as in integrating multidisciplinary teams (Table 1) [52][71].

Table 1: Comparison of CDPM activities in 7 countries [71] (Australia, Canada, Germany, the Netherlands, New Zealand, United Kingdom, United States) Adapted from the 2006 Commonwealth Fund International Health Policy Survey of Primary Care Physicians [52]

CDPM-Related Activities of Primary Care Physicians	UK	GER	NZ	NET	AUS	US	CAN
Overall Ranking	1st	2nd	3rd	4th	5th	6th	7th

It has been realized in the Canadian health care system that the challenge of managing chronic diseases and of reducing morbidity and mortality while improving outcomes for patients may be best addressed through significant quality improvements in primary care [21]. In Ontario, like many other provinces, the primary care system has been and still is under reform/renewal, with concerted efforts being placed on improving chronic disease care [20] through targeted programs and initiatives. Instead of the traditional focus on models of prevention and care that consider individual patients based on their risk factors and acute health problems, the Canadian primary care system is moving towards a more population health based approach to chronic care that focuses on the use of social and medical supports for preventing and managing disease, disability and injury, while providing continuity of care across providers [14] [15].

To help guide and inform health care organizations in chronic disease prevention and management policies and practices, the MoHLTC developed a framework that supports individual patient care through guidelines based on existing evidence, while also adopting a population health approach through community involvement and participation [7]. An adaptation of the *Ontario Chronic Disease Prevention and Management Framework* (Ontario CDPM Framework) is presented in Figure 1, and is an evolution of the Chronic Care Model (Appendix E) developed by E.H. Wagner in the United States (US), which identifies six elements of a health care system that foster effective interactions between health care teams and engaged patients [94], and that are

essential to effective chronic disease care, and that can be targeted to reduce health care costs [16][68].

Up to 2004, over 1000 health care organizations used the Chronic Care Model framework as a guide in programs aimed at quality improvements in the health care system [21]. While the Ontario CDPM Framework guidelines are intended to improve outcomes of health and functionality for patients with chronic illnesses, they are also intended to reduce the burden of illness on the population level by reducing the incidence of disease in Ontario [22]. In developing the Ontario CDPM Framework, the Expanded Chronic Care Model from British Columbia (Appendix F) and the Ottawa Charter of Health Promotion (Appendix G) were also referenced.

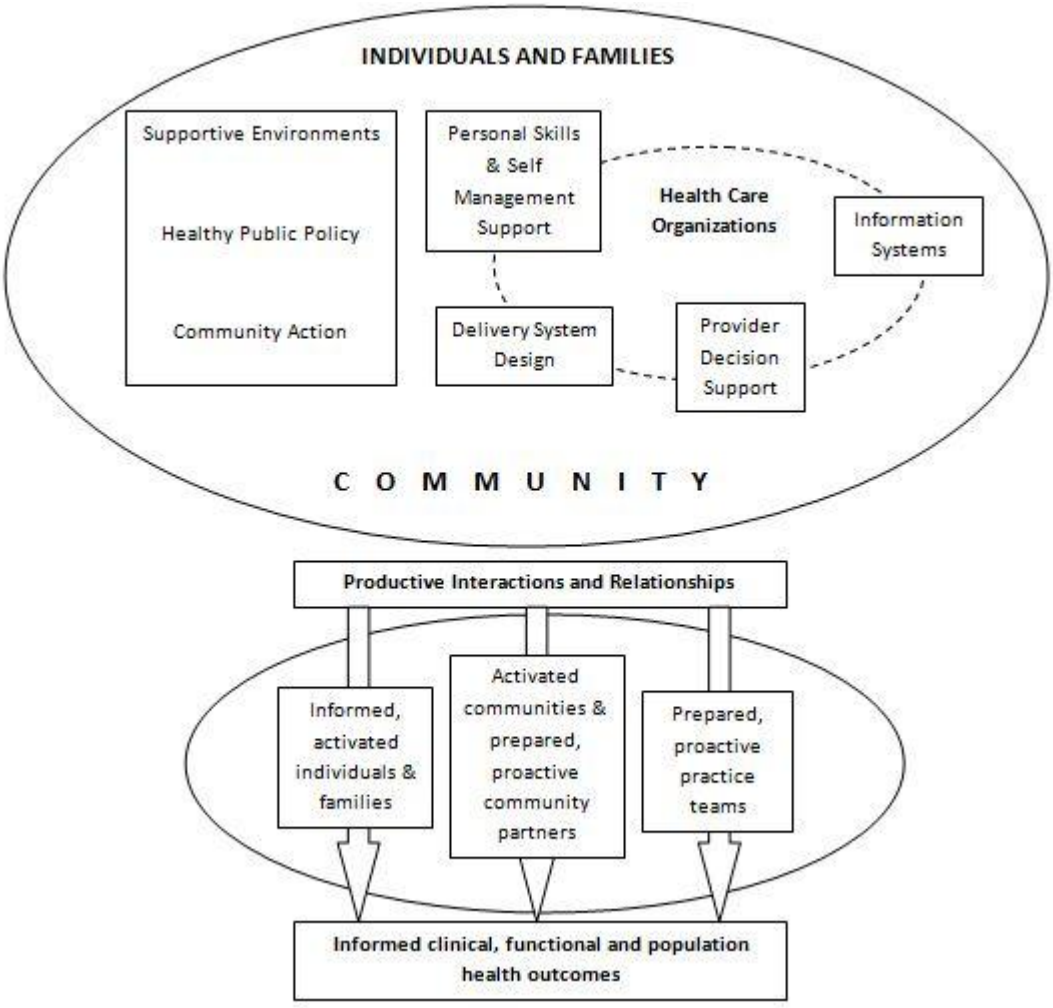

Figure 1: Adaptation of the Ontario Chronic Disease Prevention and Management Framework [43]

Like the Chronic Care Model, the Ontario CDPM Framework identifies a set of interconnected and mutually dependent health care system elements that are pertinent to successful chronic disease prevention and management initiatives which are outlined as follows:

- **Health Care Organizations** are the main providers of care and prevention programs for persons living with chronic diseases. Their role in the Ontario

CDPM Framework is to provide leadership, resources and quality improvements for proactive CDPM in communities and Ontario in general.

- **Delivery System Design** seeks to re-engineer the processes by which health care practice is organized and provided, through the introduction of multidisciplinary teams that focus on patient engagement, community needs and health promotion.
- **Provider Decision Supports** integrate evidence-based guidelines, specialist expertise, care management tools, quality and performance metrics, reporting and feedback into daily practice, while providing necessary CDPM training to health care providers.
- **Information Systems** are expected to be able to deliver timely patient and population information to providers to make improvements in care for individuals while integrating services across the system. These systems also serve to remind providers to comply with clinical practice guidelines and to evaluate and provide feedback regarding individual performance measures. One of the major functionality requirements for these electronic systems in CDPM is the ability to create registries of patients in specific risk and chronic disease categories.
- **Personal Skills and Self-Management Supports** are intended to fully engage individuals and families in participation of self-management practices, while providing the necessary support for building skills and adopting lifestyle activities that will help keep themselves healthy.
- **Healthy Public Policy** includes legislation, regulation, administrative and organizational policies that seek to improve health on an individual as well as a population level while considering inequities among groups within communities.

- **Supportive Environments** address physical, social and community environments that are secure and stable as well as support the promotion of good health, and disease prevention and management.
- **Community Action** encourages communities to publicly participate in activities that provide informed knowledge and understanding of the determinants of health that affect individual health status, while building community based partnerships and enhancing skills and resources [22].

2.3. Diabetes Management in Primary Care

Diabetes Mellitus (Diabetes) is a group of metabolic disorders that occurs when the body loses its ability to effectively secrete and / or use the hormone insulin (produced by the pancreas) to regulate the amount of glucose in the blood [29]. Left unchecked or uncontrolled, diabetes causes serious long term health complications and co-morbidities including nerve damage, blindness, and kidney and heart disease [44]. Although diabetes may occur as a result of several different metabolic disorders, the disease is generally characterized under two broad headings – type 1 and type 2 (See Appendix H for classification of diabetes).

Type 1 diabetes often occurs in people younger than age 30, and develops when the pancreas is incapable of producing (enough) insulin. Often referred to as insulin dependent, or juvenile-onset diabetes, patients with type 1 diabetes requires daily administration of insulin to control blood sugar levels [26].

Type 2 diabetes, once referred to as Adult-Onset Diabetes, as it usually affected patients during adulthood, occurs when the body loses its ability to effectively utilize its

production of insulin [26]. In recent years the incidence of type 2 diabetes has increased dramatically in children and teenagers, and is now more common in these groups than type 1 diabetes [41]. It accounts for at least 90% of all diabetes in adults [37]. It is believed that this dramatic increase in the occurrence of type 2 diabetes is associated with obesity, lack of adequate physical activity and poor diet, and can be successfully controlled and even prevented through proper monitoring and management [26].

In 2005, *Statistics Canada* in collaboration with the *Public Health Agency of Canada* designed the *Diabetes Care Module*, a set of questions intended to survey the diabetic population in Canada and to collect detailed information about care management practices of people living with diabetes [50]. The *Diabetes Care Module*, which has been adopted by several regions in Canada including Ontario, provides significant value in the reporting of diabetes care indicators [44][50].

Clinical practice guidelines for diabetes present recommendations that prevent or reduce the incidence of complications associated with the disease. These recommendations include a set of initiatives and actions focused on monitoring of the condition and following a guided treatment plan [104] which entails several activities that include foot surveillance, the control of blood glucose, lipids and blood pressure, and education to guide self-management activities. Additionally, the guidelines stress the importance of diet and exercise on regulating vascular and renal functions, and the reduction of many risky behaviors proven to initiate, aggravate or complicate diabetes in individuals [37].

Diabetes care strategies are based on physiological/biological, behavioral and exogenous factors that may affect individuals, and include screening tests that are care elements

intended to monitor individual clinical conditions in order to control and manage the disease in patients.

Physiological/biological factors such as family history and age have been shown to play significant roles in increasing one's risk of developing diabetes. In their study on the interaction between family history, obesity and inactivity on the incidence of diabetes in individuals, Sargeant et al., point out that a positive family history of diabetes increases one's risk of developing the disease [48] and according to the 2007 Canadian Community Health Survey, there is an increasing prevalence of diabetes as persons get older, with the highest rate being in individuals 65 years and older (Figure 2) [45].

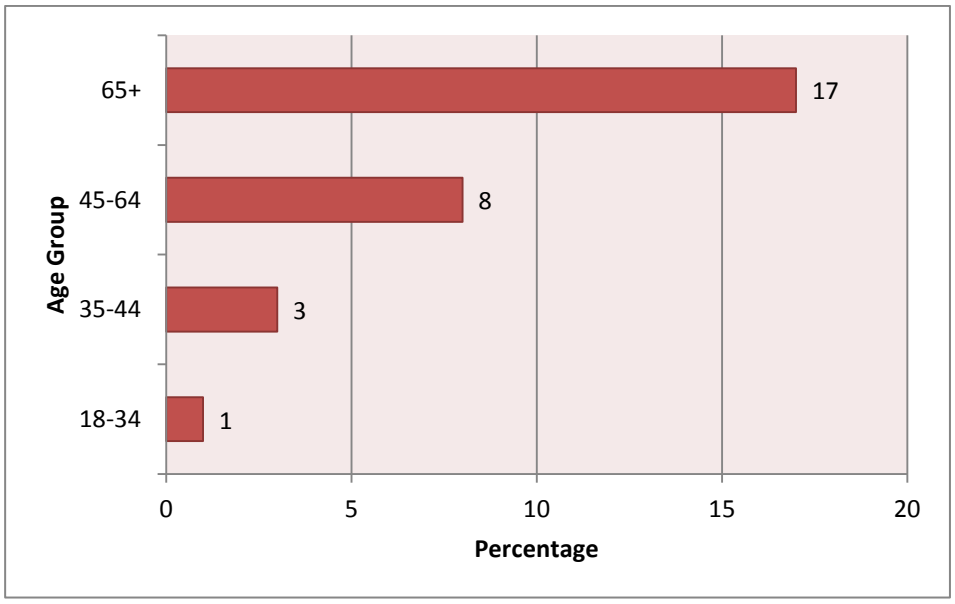

Figure 2: Percentage of Canadian population reporting a diagnosis of diabetes by age group –2007 (Adapted from Canadian Community Health Survey Cycle 4.1) [45]

Modification of behavioral factors like diet and exercise are lifestyle interventions that have strong evidence support in reducing the incidence of diabetes in individuals by 35-

58% [18]. Additionally, while anti-diabetic medications are administered to persons at high risk for developing diabetes, and have been shown to prevent or delay the onset of the disease [46], exogenous factors like substance use of recreational drugs, alcohol and tobacco have been linked to an increased incidence of early onset diabetes in individuals [49].

In 2010 the *Ontario Diabetes Cost Model* estimated that over 1.1 million Ontarians were living with diabetes. This number represents over 8% of the population of the province [27], an increase of about 3% from 2005 estimates [50], and a figure that is expected to increase to about 1.9 million by 2020 [42]. Due to the high prevalence of Diabetes (both type 1 and type 2) and its complications in Canada, and the many varied services involved in treatment, it presents a significant burden for patients and the country's publicly funded health care system. In Ontario, diabetes costs accounted for almost $5 billion in 2010 and are expected to increase by 42% to about $7 billion by 2020 [27].

Patient out-of-pocket costs for diabetes care vary widely. However the cost of diabetes is not only monetary, but also include reduced quality of life and increased risk of complication associated with the disease. It is estimated that there are over 41,000 diabetes related deaths per year in Canada and Ontario has launched a Diabetes Strategy with programs aimed at prevention, management and treatment of the disease [28].

Traditionally, the health care system, being focused on acute and episodic care, has not been adequately equipped to deal with long-term chronic illnesses like diabetes [33]. In Ontario, diabetes care usually occurs in a primary care setting [34], but is often not effectively managed when using traditional methods of care that do not focus on regular monitoring and awareness of disease risk factors over sustained periods of time.

Diabetes management is wrought with disparities in care that exist between recommended guidelines and the care patients actually receive, as well as between and among the socioeconomic classes that patients fall within [44].

More aggressive methods of care that may result in substantial cost savings to the health care system, and improved outcomes for patients, include such interventions that enhance patients' self-management skills [35] while helping providers adhere to clinical recommendations. Studies centred around interventions involving patient self-management of disease, have shown to improve at least one process or outcome of care in patients with diabetes [16]. Self-management focuses on individualized patient education and support programs that involve goal setting, and that develop enhanced skills for reducing disability, morbidity and mortality and improving quality of life. To enhance the effectiveness of diabetes self-management, individuals need to receive ongoing diabetes education as well as exposure to comprehensive health care options [46][47].

Health care systems around the world are stressing the use of electronic medical records to help providers better manage patients with chronic conditions and to improve the cost-effectiveness of care from diseases like diabetes [37]. However, in order for these electronic tools to be effective, they must have adequate decision support that assists providers in adhering to clinical practice guidelines and recommendations for the management of various diseases.

3. ELECTRONIC MEDICAL RECORD SYSTEMS IN PRIMARY CARE

The use of EMRs to manage patient care is intended to improve patient health outcomes through quality improvements in safety, care efficiency and patient monitoring over time. These electronic tools are meant to improve the delivery of health care services [57] while providing consistent meaningful information at the point of care, and have reduced complications and deaths resulting from errors related to illegible handwriting in charts and medication orders, drug interactions and adverse drug events in patients [59][60]. Ideally, EMRs enhance cognitive workflows and support clinical practice by serving as aids to decision support, clinician knowledge/memory, provider/patient collaboration, and computational functions [104]. Additionally, use of EMRs in care delivery has been documented to improve clinician adherence to clinical practice guidelines and to provide overall financial benefits to health care systems [57][58].

For many reasons, the rate of EMR adoption by primary care physicians in Canada has been very slow compared to other developed countries like the Netherlands, New Zealand, Norway and the United Kingdom (UK)[51] [52] , which all have adoption rates above 94% [61].

Figure 3 is a graphical depiction of the distribution of EMRs used by primary care physicians in eleven countries.

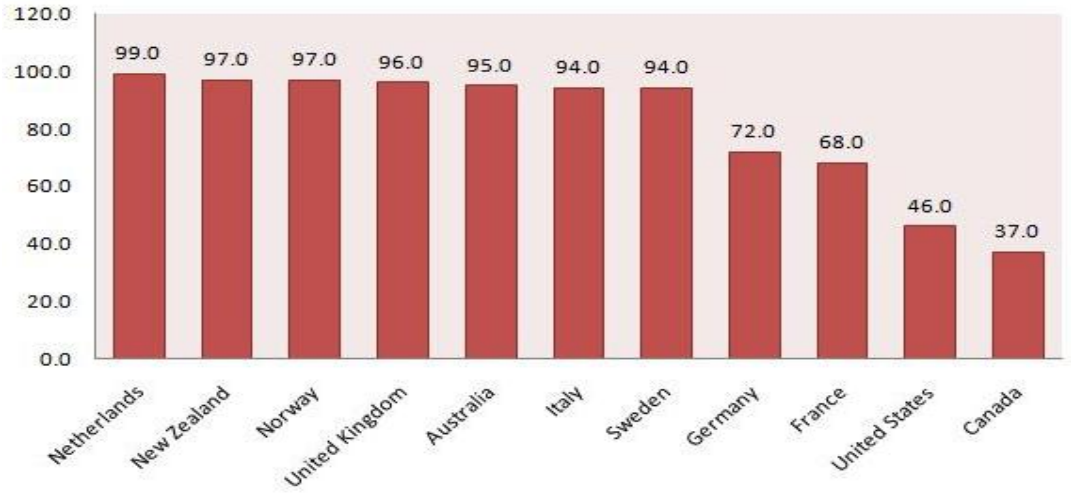

Figure 3: Percentage (%) of Primary Care Physicians using EMRs in selected countries - 2009 [61]

According to the 2007 National Physician Survey less than 13% of Family Physicians surveyed in Ontario used EMR to manage their patients [62]. By 2010 that percentage (of Family Physicians surveyed) had increased to almost 37% [53].

Boonstra et al., surveyed the available literature providing evidence for barriers to the adoption of EMRs globally by physicians, and published findings which include reasons outlined below [73]. Other authors have sited similar reasons for slow rates in EMR adoption in Canada [13][51][79][81] (this is not an exhaustive list):

- High implementation/start-up and ongoing support costs
- Uncertainty of the return on investment of EMRs
- Lack of adequate incentives to use EMRs for patient management
- Uncertainty in the technical capabilities of EMRs
- Concerns about loss of data from system crashes, power failures or other technical issues
- Lack of customizability of EMR systems
- Concerns about system and data reliability

- Lack of efficiency and usability of EMR systems
- Lack of an in-house EMR champion
- Lack of adequate technical skills
- Lack of adequate technical support for EMRs
- Lack of necessary time to implement or invest in training
- Issues surrounding relationships with and trust of vendors
- Loss of productivity concerns
- Privacy and security concerns
- Concerns over scrutiny of physician productivity
- Concerns about disruptions in clinician workflow
- Concerns about increased in clinician workload
- Concerns about lack of uniform data standards in the industry
- Lack of adequate community level participation
- Concerns about doctor-patient communication and/or interference in patient encounters

To encourage and accelerate the adoption of EMRs by physicians and specialists in primary care, *eHealth Ontario* provides funding and support through the *EMR Adoption Program.* *OntarioMD*, a subsidiary of the Ontario Medical Association has partnered with eHealth Ontario to oversee the administration of the *Adoption Program* [54], which is intended to provide physicians with a certified EMR that will integrate with practice workflows while ensuring patient safety and improved patient health outcomes [55].

eHealth Ontario expects that there will be about 9,000 new EMR adopters by 2012, resulting in an electronic record for about 75% of Ontarians [54]. The *Adoption Program* will provide physicians transitioning from paper records to EMRs and who sign an approved agreement by March 31, 2012, with transitioning support, startup funds and monthly payments that will cover EMR associated costs for a 3-year period [55].

3.1. Ontario e-Health Strategy

In 2008, the government of Ontario approved funds of over $2 billion for the development of a comprehensive e-Health Strategy for the province [38], that would focus resources on the development of electronic health records (eHRs) and the expansion of information systems that support laboratory, drug and diagnostic imaging [5].

In defining its clinical priorities and to provide value to pertinent stakeholders, the Strategy focuses on the widespread use of information technology to improve performance measures and patient health outcomes for diabetes management, medication management and wait times [38].

For primary care, this means a continuous drive to provide access to a family physician for all residents with diabetes, while using information technology to provide timely access to patient records throughout an integrated health care system that provides patient-centered care and targeted disease prevention and management programs [39].

Specifically, the Strategy stresses the widespread use of electronic medical records (EMRs) in the development of a comprehensive diabetes registry that would electronically monitor patients' receipt of best practices in diabetes care, while alerting to care gaps within the system. Additionally, EMRs and other electronic tools would facilitate e-prescribing, creation of patient medication profiles, generation of electronic prescriptions drug claims information, and improved access to health care services and programs [38].

The Strategy's success can ultimately only be determined through patient health outcomes. To ensure success e-Health Ontario has established various tactics which include the development of strong accountability channels that define roles and

responsibilities for coordination and guidance within the health care system, and an emphasis on EMR adoption and utilization by providers [38]

3.2. EMR Certification program

OntarioMD in collaboration with the MoHLTC have set out several requirements for an EMR to be considered "certified" and that will allow an adopting physician to receive funding from the *EMR Adoption Program*. These EMR requirements have been used to define the meaningful-use criteria of EMRs in the province, and include several mandatory baseline requirements that support Practice Management and Clinical Support, while strengthening chronic disease management of patients and care delivery [63].

Table 2 outlines the eight meaningful-use criteria as defined by *OntarioMD*.

Table 3 outlines the baseline EMR Requirements as defined by *OntarioMD*.

Table 2: EMR Meaningful-use criteria in Ontario [63]

Category	Criteria
Clinical Support	Entering encounter notes for patients seen
	Entering problem lists for patients seen
	Making new prescriptions / renewals
	Generation of automated alerts / reminders to support care delivery
	Receipt of lab results electronically, directly into the EMR from private labs supported by the EMR Specification
	Storage of patient care related information and documents within the EMR that originated from another healthcare provider or organization

Practice Management	Patient appointment scheduling
	Services Billing

Table 3: Baseline EMR Requirements in Ontario [64][65][66][82]

Requirement	Guidelines	
Functional	Demographics	EMR
	Encounter Documentation	Medication Management
	Lab test Management	Cumulative Patient Profile (CPP)
	Reporting, Querying,	Immunization Management
	Communications	Work Queue
	Scheduling	Billing
	System Access Management	External Document management
Data	Discrete Data Elements Data Management	
Data Portability	Import/export functions of the system regarding Practice Management and Patient data	
Interface	OLIS	Claims and Incentive Payments
	Commercial Labs	Health Card Validation
	Hospitals	
Information Technology	Architecture	Workstation Security
	Auditing and Logging	Remote Access
Support	Vendor availability	
Implementation	Training	
Privacy	Compliance with appropriate privacy laws	
Connectivity	Connectivity to OntarioMD website Drug search on OntarioMD website	
Chronic Disease Management	Data and decision support functionalities that enhance care	
Reporting	Standardized reporting of diabetes-related information	
Ontario Lab Information System	Interface for reports from repository	
Canadian Institute of Health Information	Primary health indicators data	
ePrescribing	Upcoming initiatives	
Hospital Report Manager	Hospital reports receipt	
Licensing	ISO Certification	
Data Sharing	Primary doctor/clinic/EMR Covering doctor/clinic/EMR	

3.3. EMRs and Diabetes Management

Use of EMRs by primary care clinicians continues to be advocated to reduce errors, improve quality of care in individuals, and reduce health care costs throughout the system [37][86][87]. EMRs are important tools for enabling the prevention, early detection and management of chronic illnesses in individuals. Their use has been documented to bring care guidelines to the point of care, to provide prompts and reminders for clinicians to apply specific interventions to control acute and chronic diseases and to help organize patient information [83][84] in ways that make for easy retrieval and reporting of information, creation of registries, reliable medication monitoring [88] and planning for quality improvement programs. Decision support integrated into these electronic tools helps deliver evidence-based care and promotes the application of timely interventions that improve processes of care and health outcomes in individuals [68]. Additionally, EMR use is fundamental to the *Ontario CDPM Framework*, as it can facilitate the multidisciplinary team approach [83] to care that forms the foundation upon which the Framework was built.

EMRs also provide access to chronic disease registries that help improve care at the individual level through the use of care guidelines, self-management support and medication management [34], as well as providing access to initiatives that target entire populations based on disease prevalence and incidence rates. Registries provide physicians with lists of patients in their panel at risk of developing or who already have a particular chronic illness, and are often used to develop many quality initiatives in health care systems [70][77][92]. The Ontario CDPM Framework identifies the importance of registry creation in chronic disease prevention and management [22].

The use of EMRs to prevent and manage diabetes in Canada is a fairly new phenomenon, highlighted by the low adoption rate of these electronic tools in primary care. However,

achieving quality improvements in care through EMR use can certainly be attained if EMRs are not only used consistently, but also if they are used in a manner that will effectively collect and query structured and/or coded data as required [56].

Many reasons have been identified why "usable" data that can help with the management of chronic conditions and of patients in general is not being collected [consistently]. Tu et al., suggest the recent availability of numerous EMR products coupled with the lack of standardized formats for entering clinical data in EMRs as challenges in the identification and management of chronic diseases by physicians [69]. Hasnain-Wynia et al., identified concerns regarding unwillingness by patients to provide information as well as discomfort from staff to ask for information from patients, privacy issues and uncertainty of the usefulness of data collected as barriers to the collection of patient data in physician practices [72].

Historically, the Canadian health care system has relied on physician billing and hospitalization administrative data to identify instances of diabetes within a population [69]. However, these kinds of data lack the clinical information necessary to measure aspects of diabetes care that would help better monitor and manage the disease [85]. Using an EMR to collect structured and coded clinical data about individuals [88] regarding demographics like age and gender, various care elements, medications, laboratory tests and other patient specific information, allows for more accurate identification and reporting of diabetes within the province [69].

3.4. Diabetes Reporting Requirements

EMRs specifications for "certified" EMRs in Ontario (as defined by *OntarioMD* in collaboration with the MoHLTC) outline several requirements for diabetes reporting by physicians in the province. These system requirements encourage the collection of structured and coded data that can be used for the effective management of diabetes in individuals, creation of diabetes registries and quality improvements in office practice and program planning [67]. Table 4 outlines the EMR diabetes reporting requirements as defined by *OntarioMD*.

Table 4: EMR Diabetes Reporting Requirements in Ontario [67]

Requirement	Guidelines
Patient Demographics	Patient demographics and contact information Primary physician ID
Diabetes Diagnosis	Diagnosis code, diagnosis code system name, onset date
Medications	Prescription details OHIP physician number of prescriber Patient compliance
Vaccinations/Immunizations	Immunization details Administration or refusal details and flag
Laboratory Results	Lab details Test details Reviewer details OHIP physician number Flags
Care Elements	Smoking status details Weight details Height details Waist circumference details Blood pressure details Screening for further complications Counselling details Self-management Goals, Barriers, Training details Glucose monitoring and events
Report Information	Report start date, end date, run date

3.4.1. Patient Demographics

Patient demographic information in EMRs represents an important link in the management of chronic diseases like diabetes. This information serves to identify a patient with a clinician as well as validates the individual's identity for information transfer and quality improvement programs [89]. Demographic information is often verified and updated in an EMR at each clinic encounter. Primary physician ID is also categorized with demographics and is a necessary component when billing or transferring information to third parties.

3.4.2. Diabetes Diagnosis

Diagnosis codes in EMRs are specific and compact, and have an added use to support documentation for reimbursement when clinicians bill third parties for patient care [90]. Used consistently, these codes provide structured input into EMRs and enable the indexing, storage, retrieval and aggregation of clinical data [91]. The current EMR Specifications for diabetes in Ontario specify the use of the *International Classification of Disease* codes for the diagnosis and reporting of diabetes [67]. Certified EMRs are required to have the ability for clinicians to enter the diabetes diagnosis code of 250 in a patient problem list or profile.

3.4.3. Medications

Decision support in EMRs that present alerts during prescription completion has been found to aid medication management and contribute to reductions in adverse events and an overall increase in patient safety [11]. Additionally the use of EMRs to manage medications facilitates patient compliance and monitoring and the implementation and evaluation of medication-related interventions, and has the effect of improving quality of care and health outcomes in individuals [93].

3.4.4. Vaccinations / Immunizations

Individuals living with diabetes are at high risk for complications and death resulting from various viral diseases [24]. Public health guidelines like the recommendations for immunization in individuals are thus important facets to the management of patients with diabetes, and these guidelines can be adhered to in EMRs with the help of rules/reminders that can be setup for clinicians to be reminded of immunization schedules for their patients. The EMR Specifications stress the ability for EMRs to be able to not only record the details of immunizations and their administration, but also to flag when a patient refuses or misses an immunization [67].

3.4.5. Laboratory Results

A critical part of diabetes management is the close monitoring of blood glucose and lipid levels in individuals [46]. In order to maintain and improve patient health, timely interventions need to follow abnormal laboratory test results. Decision support within EMRs can flag abnormal results for further intervention, and this kind of management has been shown to facilitate timely follow-up of abnormal test results [134], safeguarding patient safety [135].

3.4.6. Coordination of Care

Diabetes is a complex disease that, like other chronic diseases, requires management by multiple care providers, thus increasing the risk of poor care coordination and compromising patient safety by increasing the likelihood of medical mistakes [100][101]. One of the problems facing patients with chronic diseases is the lack of continuity of care beyond episodic illnesses [99]. Coordination of care among multiple providers and between providers and patients is thus an important component of disease

management, and has been heralded as having the potential to improve patient safety and medical outcomes, and decrease medical costs [97]-[99], and is essential when continuity of care is fragmented [96][99]. EMRs can improve the management and coordination of care through the ready availability of patient information at the point of care [54], however their utility in that regard can only be maximized through constant evaluation of clinical care processes, interoperability, and clinician workflow [97].

Currently, some practices in Ontario are able to access hospital discharge reports by downloading summaries from hospitals and attaching them to patients' charts in the EMR [54]. This access to discharge summaries provides a level of continuity of care for patients managing specific instances/episodes of illness. Although many practices use their EMRs to coordinate care with other clinicians within their team (using the same EMR) through electronic referrals, coordination of care with providers in other teams/practices using the EMR continues to be an interoperability challenge in the province.

3.4.7. Care Elements

There is strong evidence supporting several interventions employing screening tests as care elements intended to monitor individual clinical conditions in order to prevent and manage diabetes in individuals [18]. These interventions can be tracked using structured and coded input into an EMR, resulting in the availability of data that has the potential to improve outcomes in patients through the initiation of interventions, the creation of improvement programs and the creation of disease registries. Although not a comprehensive list, this paper will address glycemic control, blood pressure monitoring, cholesterol management, body mass index (BMI), foot care, and self-management care guidelines and their applicability to EMR use in supporting diabetes care in individuals. Additionally, various diabetes risk factors such as smoking and alcohol consumption will be addressed.

The Canadian Diabetes Association (CDA) 2008 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada recommends that average blood glucose levels - glycemic levels - in individuals with diabetes be monitored closely and checked about every 3 months when targets are not being met, and about every 6 months when targets have been consistently met [46]. An important part of diabetes management measured by haemoglobin A1C, control of glycemic levels reduces the development of various vascular complications in individuals [24] [50]. Target levels for satisfactory A1C levels are currently at 7.0% and below [24].

Vascular protection in individuals living with diabetes is very important in the prevention and control of micro- and macrovascular complications resulting from the disease. For this reason, clinical guidelines suggest that blood pressure (BP) be checked at every clinical visit, and optimized in people with diabetes at levels below 130/80 mm Hg [46] (BP is measured in millimeters of mercury - the systolic/top reading represents the maximum pressure exerted when the heart contracts, while the diastolic/bottom reading represents the minimum pressure in the arteries when the heart is at rest [74]). Optimum blood pressure levels in individuals with diabetes is often controlled through medication and diet. However moderate weight loss of between 5% and 10% of body weight has also been shown to improve BP levels [24]. Lifestyle interventions to reduce weight and limit sodium and alcohol intake are encouraged for the control of BP.

Vascular protection also applies to the control of high blood cholesterol (dyslipidemia / lipid disorder) in all individuals. High levels of low density lipoprotein (LDL-C) has been associated with atherosclerosis, a condition in which narrowing of blood vessels occurs [78], and can lead to complications associated with cardiovascular disease (CVD), and death. People living with diabetes are especially susceptible to CVD and thus LDL-C levels should be monitored carefully. Optimum lipid levels in individuals with diabetes is often controlled through medication and diet, but moderate weight loss of between 5% and

10% of body weight has also been shown to improve lipid levels of persons with lipid disorder [24]. Canadian diabetes care guidelines recommend a target LDL-C of no more that 2mmol/L for people with diabetes [24] - LDL-C levels are measured in millimoles per litre.

An increase in body Mass Index (BMI), an estimate of the body fat of an individual, that is calculated using one's height and weight, has been found to have a direct correlation with one's increased risk of developing diabetes [48]. Diabetes care guidelines recommend that individuals with a BMI of at least 25kg/m^2 should be screened for type 2 diabetes at least once every three years [32]. Substantial improvements in insulin sensitivity and glycemic levels have been achieved in individuals with diabetes through moderate decreases in body weight and BMI [24], and thus care guidelines often include lifestyle interventions that target weight loss through diet and physical activity.

Foot care in people with diabetes is very important in reducing morbidity and mortality as well as in reducing health care costs [24]. Infection resulting from foot ulcers and other wounds can progressively lead to foot amputation if not addressed promptly. Foot complications accounted for over 30% of all discharges of diabetic patients in the United States in 2007 [76]. Regular foot examination and evaluation of amputation risk should be done by a health care professional at least annually and more often for persons at high risk of complications. Additionally, callus debridement, aggressive treatment of foot ulcers and wounds, education for self-management and professionally fitted therapeutic footwear are all part of foot care regimen recommended for persons with diabetes [24].

The importance of patient self-management to improve outcomes for patients and offer cost savings to the health care system has been cited by many authors [30][35][47][94][95]. Diabetes prevention and management should include various levels of education that

enhance patients' self-management skills while ensuring compliance with clinical recommendations for the disease. To enhance the effectiveness of diabetes self-management, individuals need to receive ongoing diabetes education as well as exposure to comprehensive health care options [46][47]. Studies centred around interventions involving patient self-management of disease, have shown to improve at least one process or outcome of care in patients with diabetes [16]. Self-management focuses on individualized patient education and support programs that involve goal setting [16], and that develop enhanced skills for reducing disability, morbidity and mortality and improving quality of life.

Care guidelines for the management of diabetes included dietary and lifestyle behavior specifications that reduce or eliminate risk factors known to increase the incidence of diabetes or worsen conditions in individuals. These guidelines include very moderate alcohol consumption [18][24][31][35], and tobacco/smoking avoidance or cessation in individuals [24][35][46]. EMRs are currently being used to track, identify and monitor individuals who would benefit from smoking cessation counseling, based on their daily tobacco intake [80]. They can perform similar functions of tracking and monitoring individuals for alcohol counseling (based on the number of drinks per day/week) [102]. This kind of data mining is used in the creation of diabetes registries.

Structured data extracted from EMRs in Ontario are expected to be used in the creation and maintenance of diabetes registries, as well as for use in practice and program planning [67]. In order to generate any kind of report using an EMR, data must be extractable. Terry et al., define five options for data extraction in EMRs (Table 5), all of which may not be available in all EMRs [56].

Table 5: Options for data extraction in EMRs in order of increasing complexity [56]

Method	Details
1. Pre-Determined Queries	Pre-loaded query options to select from
2. Simple Customizable Queries	Some user input available to customize query
3. Advanced Customizable Queries	More user input available to customize query than option 2. Use of Boolean logic
4. Structured Query Language (SQL) Interface	Ability to generate tabulations
5. Data Extraction and Analysis with Database tools	Ability to conduct complex searches using entity relationship diagrams and data dictionaries

Regardless of the method of extraction, reporting should be consistent and accurate. To ensure consistency and accuracy in reporting, methods of entering data into the EMR must be consistent and well defined, while care must be taken in defining queries that go beyond pre-loaded or pre-determined query logic.

4. EMR USABILITY AND CARE WORKFLOWS

EMRs have been touted as one of the quality improvement tools that have changed the face of primary care by improving preventative care, patient safety and monitoring over time [107]. They enhance cognitive workflows and support clinical practice by serving as aids to decision support, clinician knowledge/memory, provider/patient collaboration/coordination, and computational functions [104]. Table 6 presents the varied roles of the EMR in the context of specific tasks that may be performed in routine patient care.

Table 6: EMR Roles and the Performance of Tasks in Patient Care. *(Adapted from AHRQ EHR Usability Evaluation and Case Framework)* [104]

Care Tasks	EMR Roles			
	Memory	**Computation**	**Decision Support**	**Collaboration**
Review patient record	History and demographics	Contextual view of patient health	Tailored individualized care	Incorporate info from other sources
Conduct patient assessment	Prompt for information	Calculates values (e.g. BMI)	Clinical reminders	Coordination of care
Determine clinical decision	Relate assessment to patient history	Perform trending of information	Support of care plans and CPGs	Provide instructions for other care teams
Develop treatment plan	Care plans and CPGs	Apply tailored individualized care	Adjust CPGs according to individual	Patient summary, educational tools
Order required services	Review previous results	Determine provider/location	Alignment with OHIP requirements	Referrals and other provider communication
Prescribe medications	Medication history, allergies, interactions, formulary	Calculation of dosages	Interactions, events, effectiveness	Patient instructions and education/self-management
Update patient record	Diagnoses and treatment codes	Prompts/populates automatically	Legal and OHIP guidelines	Patient education and care coordination

EMRs improve the delivery of health care services [57] and coordination of care [54], provide meaningful information at the point of care, and have reduced complications and deaths resulting from errors related to illegible handwriting (in charts and medication orders), drug interactions and adverse drug events in patients [59][60][107]. Use of EMRs in care delivery has also been documented to improve clinician adherence to clinical practice guidelines and to provide overall financial benefits to health care systems [57][58].

Despite these rave reviews about EMRs, adoption in North America has been slow [51][52], and even when they have been adopted, full benefits are not being realized by many due to underutilization and inefficiency in use [108]. A major barrier to adoption of EMRs by physicians is resistance to use resulting from experiences that invoke computer apprehension and concerns of loss of productivity in time and workflow, and less physician-patient interaction [110]. A disconnect between EMR functionality and workflow leads to extra effort being spent on learning new activities and/or on finding workarounds that are less than adequate [119]. Another concern regarding EMR adoption is loss of information – not from system failures (although Boonstra et al., cite system failures as a barrier to EMR adoption [73]), but from physicians' inefficient information gathering and reasoning skills when using an EMR – skills that must be developed and that are quite different from those required when using paper charts [107]. Patel et al., suggest that the difference in data organization between an EMR and a paper chart also affects the nature of the physician-patient dialogue [114]. In 2009, the Columbia Daily Tribune reported a news item uncovered by the Associated Press regarding usability issues that caused unnecessary or incorrect drug doses to be administered to patients at various Veterans Affairs health centers in the United States, seriously endangering patient safety [128][129].

These kinds of user-system based problems and concerns (and several others) are EMR usability issues that have often been blamed for poor adoption rates, underutilization of systems, inability [of EMRs] to provide quality improvements in health care and endangerment of patient health [73][103][109][110][111][128].

Usability, as defined by the *International Organization for Standardization* pertains to the degree to which specified users of a particular product can perform a specific set of tasks effectively and with efficiency and satisfaction [112]. However, many misinterpret usability of a product to be the extent to which a user is satisfied with the product [113], without taking into account the product's ability to support productivity, cognition and workflows. Morgan Price [130] - informatics specialist at University of British Columbia - identifies three levels of usability that affect clinicians in their use of EMRs and that should integrate with practice workflow:

- Biomechanical/physical - buttons, clicks etc.
- Cognitive – how EMR is designed to help you think to best do your work without too much extra effort
- Social – how EMR supports interaction with patients and staff (patient encounter and coordination of care)

In order to provide the benefits that EMRs are expected to provide, they must support clinician workflows [110] while demonstrating good usability through assistive decision making, quick task performance and minimal cognitive load [103].

Usability of any product or system must be addressed with appropriateness to a specific context of use [115]. Regarding primary care, usability of an EMR is dependent on interactions between clinicians, clinical tasks and the EMR itself [120]. In this paper, EMR usability will be addressed from the perspective of physician, nurse and dietitian users' tasks in primary care, non-mobile settings. EMR usability will be evaluated in effective

diabetes management while focusing on patient safety, health care provider workflow and adherence to clinical practice guidelines.

4.1. Usability Guidelines

The following usability guidelines have been adapted from the 2009 Healthcare Information and Management Systems Society (HIMSS) Principles and Proposed Methods of EMR Usability Evaluation and Rating [103].

Simplicity and Naturalness

There is a lot of clinical data contained in electronic patient charts that may be presented, and users need to be able to find and understand information quickly and easily. The presentation of concise uncluttered information, and system functionality that is task oriented, intuitive, and easy to use based on a user's context, speaks to the simplicity and naturalness in design of an EMR [116][117], that impacts user adoption, learning effort , productivity and clinical errors [121]. According to Jakob Nielsen, when using an application, the chances of picking the correct option at any time are increased when the user has less information to sift through and understand [122].

Effective Information Presentation

The nature of [clinical] information contained in EMRs makes these systems quite complex and as a result the proper presentation of information is important in achieving efficiency in workflows, maintaining patient safety [103] and supporting quality improvement in diabetes care. EMR use, clinical workflow and patient safety are highly dependent on screen readability and the arrangement of information on screens that highlight key data [123]. Careful consideration must be given to visual density and the use of color in EMR design. Search times and errors increase with screen density [118], while consistency in the use of color is linked to a reduction in errors and an increase in

patient safety, as color context strengthens the meaning that is conveyed to the user [103].

Efficient Interactions

Although clinicians vary in the manner and speed with which they perform tasks, their interactions with an EMR may produce fatigue and frustration. To increase efficiencies, EMR interactions should be such that routine tasks can be completed through a minimal number of steps and with a minimal amount of navigation [103], while preventing mistakes and allowing for easy avenues to correct mistakes [123]. Brown [124] points out that EMR implementation failures often arise as a result of systems that are abandoned because they increase clinician workload through excessive mouse clicks to navigate to the place of interest, lack of intuitiveness and overpopulation of screens and menus.

Ideally, EMRs should be designed to fit in with clinicians' workflows. However, clinicians often purchase generic EMRs rather than flexible systems that can be customized to their needs. For this reason it is often necessary to redesign office workflows around existing EMR applications so that application integration into clinical practice is less intrusive.

The use of shortcuts, auto-tabs, default values and boxes that limit scrolling [103] are a few ways that efficiencies may be achieved while users interact with EMRs. Additionally, tablets (that accommodate handwriting) and voice recognition add-ons are useful data entry avenues for EMR users.

Efficient Use of Language

EMRs collect structured discrete clinical data, and it is important for all language and terminology used in an EMR to apply to the clinicians' work context, and that it is appropriate, familiar, meaningful and unambiguous [103][111][123].

Context Preservation

Context preservation refers to the extent to which screen changes and visual interruptions (like dialog boxes) affect a user's ability to complete a particular task [103]. Visual interruptions cause users to shift attention to some other part of the screen rather than where the task at hand is located, and increases visual searching. Measures should be taken in EMR design to limit visual interruptions and/or to make them seem transparent in task completion. Additionally, screen changes should be an immediate reflection of a user's action and should appear in a format that is familiar to and expected by the user.

Minimize Cognitive Overload

The design of an EMR should be such that it provides easy access to the information stored within it. Transparency in EMR design reduces the guess-work of finding out how tasks are performed or where functions are located, and is a key component in minimizing cognitive overload for clinicians. EMRs accommodate to limits of human memory [125] since patient information is stored for later use and care guidelines, medication lists, diagnoses etc., are readily available to aid in decision making.

Efficiencies in task performance tend to decline as the number of tasks increases and their frequency decreases [119]. For this reason, EMRs should be designed so that task performance occurs through recognition and identification of functions and options rather than through memorization of steps to achieve functionality.

Consistency

Consistency in EMR design with other familiar applications facilitate transference, a process by which previously acquired skills and knowledge affect the learning of new information [119]. In other words, EMR buttons and dialog boxes should be consistent in design throughout the application as well as with other applications that users are

familiar with. This consistency lessens the learning curve for a user and aids in efficient EMR use and reduces the likelihood of errors [103].

Forgiveness and Feedback

Forgiveness in EMR design refers to the extent to which the application allows a user to explore various functions without losing information or other unintended consequence [103], by allowing the user to undo or reverse an activity [126]. Additionally, forgiveness provides a user with a clear exit from the application or a function within the application without being hassled by too much dialog [127]. Feedback refers to the information provided to a user to confirm (within a reasonable time) an action that has been taken or is about to be taken. The provision of error messages presented in simple language that offer a suggested solution, is a component of good feedback. Forgiveness and feedback help reduce errors and provide the user with ways to recover information when a mistake is made. These functions are especially important in clinical settings as they help minimize cognitive load, reduce medical errors and increase patient safety.

Help and Documentation

Although the typical user does not like to use documentation, it is useful for it to be available if needed. EMR documentation should be provided in plain language and easy to search while applicable to the user's context.

5. DATA COLLECTION METHODOLOGY

5.1. Literature Review

To decide on what information should be collected and how it should be collected in order to meet the objectives of this study, a systematic review of scientific literature within the ISI Web of Science, PubMed and Medline databases was conducted between February and April 2011. Search terms used included individual and combinations of key words containing the following:

- Chronic Disease Management and/or CDPM
- Clinical Practice Guideline and or CPG
- Diabetes and/or Diabetes Management
- Electronic Medical Record and/or EMR
- Family Medicine
- Family Practice
- Primary Care
- Usability
- Use
- Workflow

The search yielded 1655 articles from peer reviewed journals from Canada and internationally, and they were screened for inclusion criteria and to remove duplicates before being selected for review. Inclusion criteria were limited to:

- English Language
- Human Subjects
- Qualitative and Quantitative Data
- General Practice and/or Primary Care and/or Family Practice/Medicine
- Publication dates between 2000 and 2011

Of the 1655 articles, 189 were selected for review. Further screening eliminated 60 articles, and combined with an updated search, a total of 140 articles meeting the inclusion criteria. While 24 of the included articles specifically addressed usability of EMRs, only 3 were from a Canadian context. The literature search was also extended to other databases such as the Canadian Government, Google Scholar, LexisNexis, and other medical and corporate websites to gather information and reports that may be available and relevant to this paper. Table 7 shows the categorization of included peer reviewed articles by country and usability focus, while Figure 4 presents a flow diagram for the article selection process.

Table 7: Peer reviewed articles by country and usability focus

Country	Total Quantity	Usability of EMRs
Australia	2	0
Canada	18	3
Denmark	1	0
Greece	1	0
Hawaii	1	0
India	1	0
Israel	1	1
Mexico	1	0
The Netherlands	7	3
Norway	3	1
Singapore	1	0
Slovenia	1	0
Taiwan	1	0
United Kingdom	3	0
United States	98	16

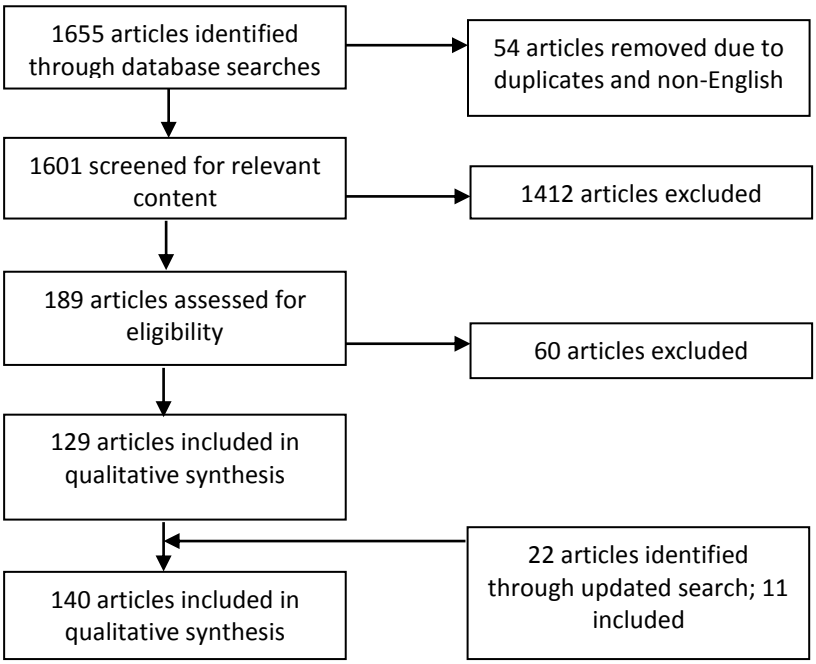

Figure 4: Flowchart for article selection process

5.2. Data Collection

Clinical practice guidelines for the management of diabetes in individuals specify the support of care with an integrated, multi- and interdisciplinary group of health care professionals, normally referred to as the *Diabetes Health Care* (DHC) team [24]. In addition to a family physician and/or specialist, the core DHC team also includes a nurse and dietitian – both usually diabetes educators.

Two web-based surveys were conducted to assess the usability of EMRs used by Ontario primary care physicians and nurses. For both surveys, participant contact information was obtained via word-of-mouth or publicly available lists. Additionally, interviews were conducted with four dietitians in primary care to gain a qualitative perspective of EMR usability with regard to diabetes management. The surveys and interviews were designed around Price's [130] three levels of usability that affect physicians in their use of EMRs (provided in more detail in the section of this paper that addresses *Usability*), and are based on the models presented in Figures 5, 6 and 7. The survey and interview questions were validated by two health informaticians and various volunteers recruited by the student investigator.

The survey and interview procedures and questions were approved by the McMaster University Research Ethics Board (Appendix A).

5.2.1. Models of EMR Usability

This usability study was intended to gather information for an initial verification of three usability models representing physicians, nurses and dietitians (Figures 5, 6 and 7 respectively). These models are intended for Structured Equation Modeling evaluation through Partial Least Squares of the path structures that link the various constructs in the models. Table 8 shows the constructs and number of items used in each construct

for the three usability models. Although the sample sizes were not sufficient to validate the models, sufficient data were gathered to allow non-parametric studies of some of the relationships. Much larger samples would be needed in order to develop properly validated regression models.

Table 8: Constructs Used in the Physician, Nurse and Dietitian Models

Construct	Physician	Nurse	Dietitian
IT Innovation	5		
EMR User Interface / Application Design including: Appointment Scheduling Order Lab Tests Patient Record Review	12	 1 6 4 3	4
Decision Support	6		
EMR Satisfaction, Effectiveness, Efficiency	7	4	4
Provision of Information about diabetic patients	10		
Support for CPGs	5		
Consultation with Patient & Chart Update	6	9	5
Care and Treatment Plans & Referrals	7		2
Manage Medications	6		
Information to Patients	5	1	1

5.2.1.1. Physician Survey

A total of 16 primary care physicians from various parts of Ontario participated in the online survey which was conducted from June to September 2011, and administered via LimeSurvey hosted at McMaster University. Of these participants, 50% were male and 50% female and most (88%) have been practicing medicine for over 21 years. All participants completing the survey are currently using an EMR to manage patients in their practice, and all but 2 participants have been using an EMR for over 5 years.

Participants responded to 12 demographic and other questions regarding their own particular situations. Additionally, they completed 14 sections of the survey relating to

their use of information technology, patient consultations, chart management, care and treatment plans, information collection and provision, user interface and application design and satisfaction as shown in the constructs presented in Table 8 and modeled in Figure 5. The model presented (Figure 5) shows the expected relationships between and among the constructs given in Table 8. Due to the small sample size, structured equation modeling could not be applied to validate

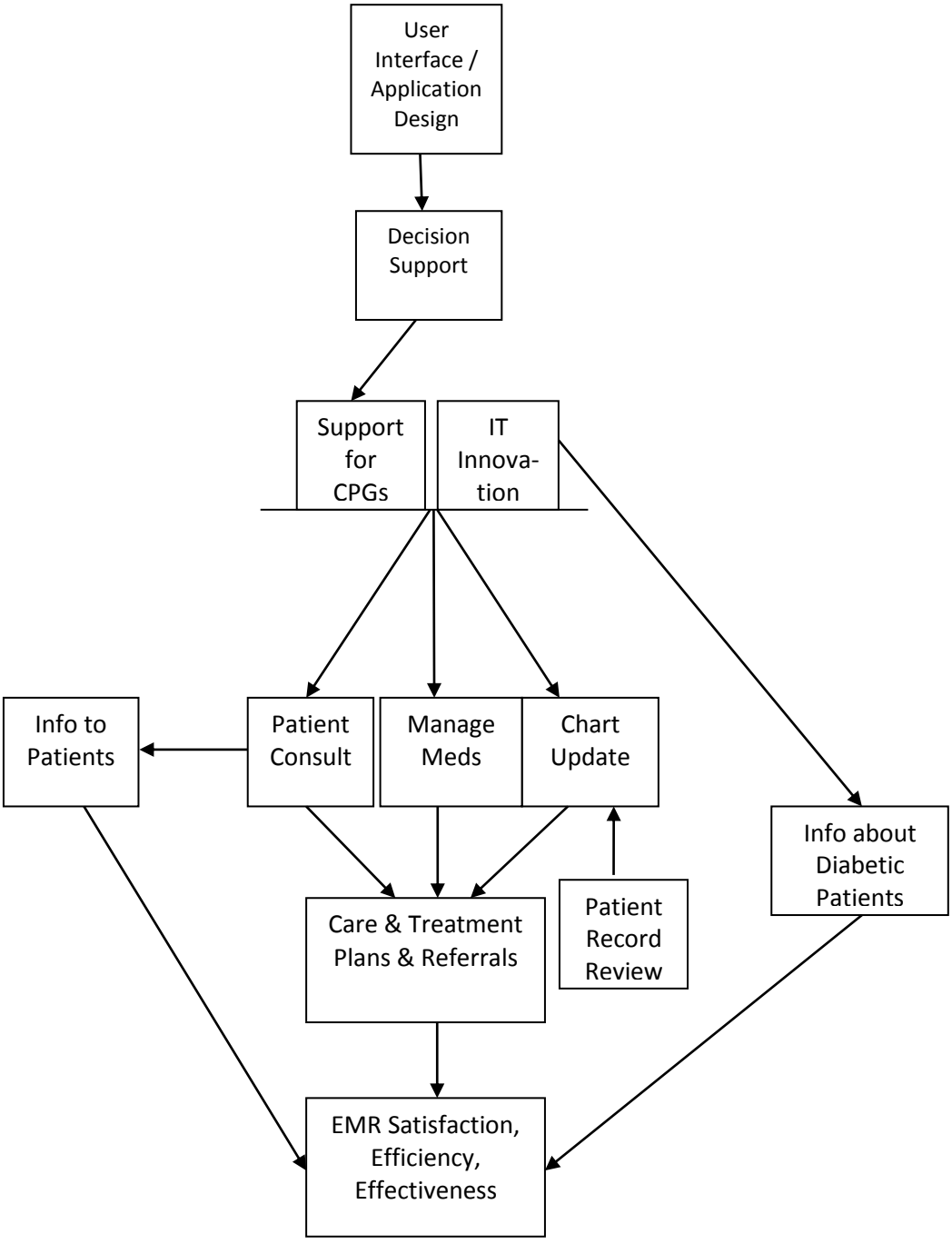

Figure 5: Model of Physician EMR

the model. The construct responses were entered on a seven point Likert Scale with an eighth option for “no answer” included. The possible responses for each statement were Strongly Disagree (1), Disagree (2), Somewhat Disagree (3), Neither Agree nor Disagree (4), Somewhat Agree (5), Agree (6), Strongly Agree (7), No Answer. 75% of respondents entered additional comments regarding their management of diabetes using their EMR and their satisfaction with their EMR. A full copy of the physician survey is presented in Appendix J.

5.2.1.2. Nurse Survey

A total of 5 nurse respondents in primary care in Ontario participated in the web-based survey conducted from June to September 2011, and administered via LimeSurvey hosted at McMaster University. Of the participants, there were 3 females, 1 male and 1 participant choose not to provide their gender. Participants’ specific occupations were either registered nurse or nurse practitioner.

Like the physician survey, participants responded to 12 demographic and other questions regarding their own particular situations. Additionally, they completed 7 sections of the survey relating to patient consultations, provision of information, application design and user interface and satisfaction as shown in the constructs presented in Table 6 and modeled in Figure 6. The model presented (Figure 6) shows the expected relationships between and among the constructs given in Table 8. Due to the small sample size, structured equation modeling could not be applied to validate the model. The construct responses were entered on a seven point Likert Scale with an eighth option for “no answer” included. The possible responses for each statement were Strongly Disagree (1), Disagree (2), Somewhat Disagree (3), Neither Agree nor Disagree (4), Somewhat Agree (5), Agree (6), Strongly Agree (7), No Answer. 3 of the participants entered additional comments regarding their management of diabetes

using their EMR and their satisfaction with their EMR. A full copy of the nurse survey is presented in Appendix K.

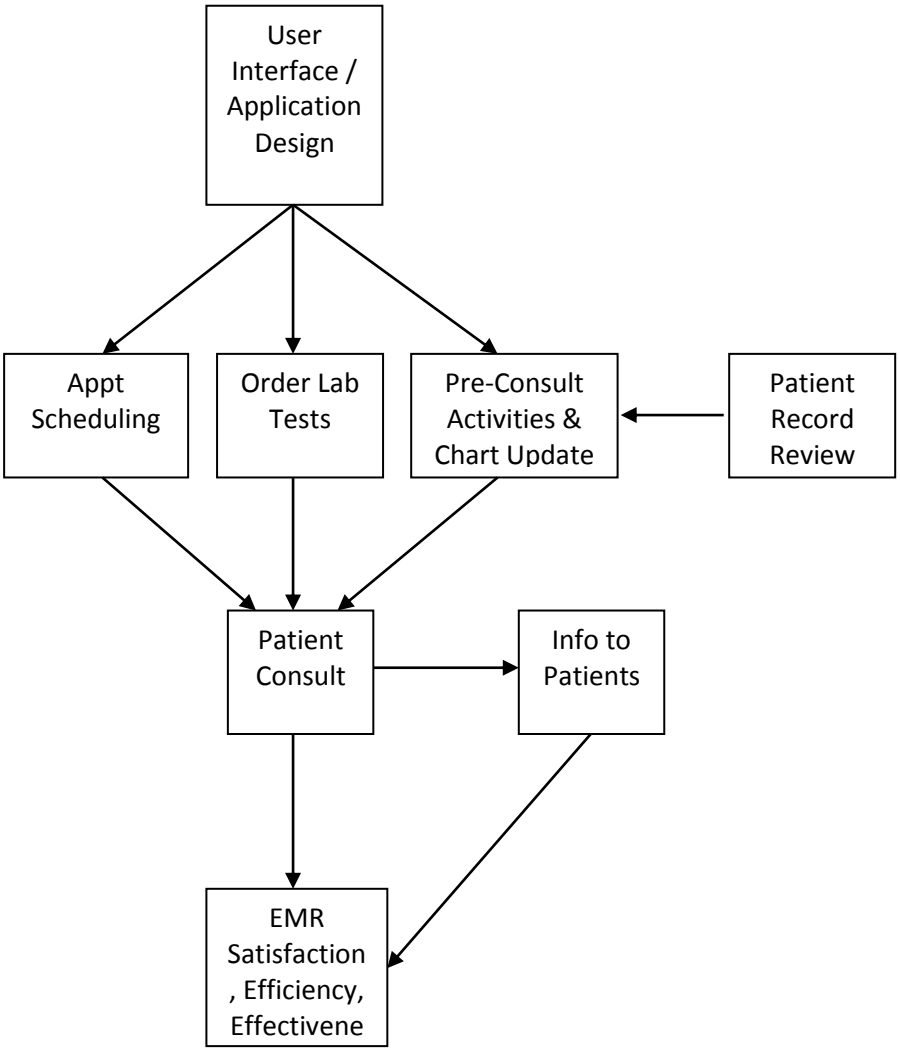

Figure 6: Model of Nurse EMR Usability

5.2.1.3. Dietitian Interviews

In order to gain a qualitative perspective of EMR usability with regard to diabetes management, interviews were conducted with 5 primary care dietitians, 4 of whom are also diabetes educators, and who currently use an EMR to manage the care of patients on a daily basis. The interviews were conducted in August and September 2011. The participant dietitians operating out of different practices, are part of a Family Health Team where various health care professionals work collaboratively to provide health care services to persons in local communities. Patient care is coordinated among members of the team who promote healthy living and participate in chronic disease prevention and management initiatives. The dietitians used one of two EMRs in their care of patients. One dietitian operated out of two different practices and used both EMRs to manage patients.

At the time of the interview, participants completed responses to 11 demographic and other questions regarding their own particular situations, as well as 4 categories of questions relating to their interactions with (review and update of) the electronic patient chart, their consultation with patients and their satisfaction with the EMR. The constructs used in the dietitian questionnaire are presented in Table 8 and modeled in Figure 7.

The construct responses were entered on a seven point Likert Scale and the possible responses for each statement were Strongly Disagree (1), Disagree (2), Somewhat Disagree (3), Neither Agree nor Disagree (4), Somewhat Agree (5), Agree (6), Strongly Agree (7).

Participants were presented with a case scenario describing a patient with type 2 diabetes and information available in the patient's electronic chart, and were asked 5 questions aimed at helping them describe their interactions with the EMR based on the particulars provided in the case scenario. Participants were then asked to provide any

additional information regarding their use of the EMR in managing diabetes and their satisfaction with the EMR. Each question completion and interview session lasted for about 45 minutes. A full copy of the dietitian questionnaire and interview questions is presented in Appendix L.

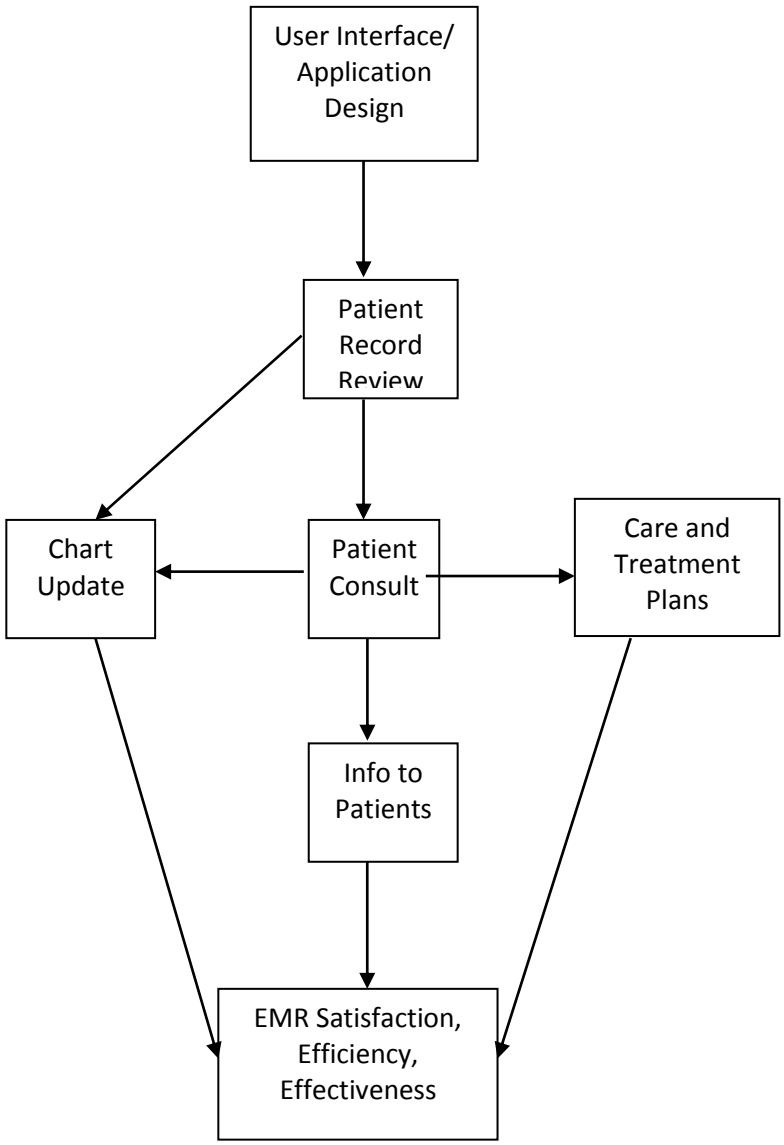

Figure 7: Model of Dietitian EMR Usability

6. DATA ANALYSIS AND RESULTS

6.1. Physician Survey

A total of 105 invitations were sent to primary care physicians from various parts of Ontario to participate in the online survey which was conducted from June to September 2011, and administered via LimeSurvey hosted at McMaster University. Of these, 18 primary care physicians participated in the online survey. Additionally, a total of 12 paper versions of the online survey were delivered to various practices around the city of Hamilton for physicians to complete, of which 1 physician completed the survey. The response rate for the survey was 16.2%. Reasons for low response rate in the physician survey may include:

- Initial technical problems with LimeSurvey – within 48 hours of sending out initial survey invitations, seven physicians sent emails indicating that they were not able to access the survey. Although the problem was later rectified by McMaster support staff, there is no telling how many persons experienced problems and did not bother to again try to complete the survey.
- Time of year – contact with some practices to solicit participation from physicians indicated that many physicians had taken vacation and were unavailable to complete the survey
- Busy schedules – contact with some practices to solicit participation from physicians indicated that many physicians were just too busy to complete the survey or were already inundated with similar solicitations and chose not to participate.

Of the total of 19 participants, 3 did not use an EMR to manage patients in their practices, and thus were not eligible to complete the survey. Of the remaining 16 participants who all used an EMR to manage patients in their practices, 50% were male

and 50% female and most (88%) have been practicing medicine for over 21 years. All but 3 eligible participants had been using an EMR for over 5 years. 69% of the physicians surveyed used an EMR from the same vendor. Regarding patient care, 81% of the participants surveyed consulted with over 20 patients per day, with 23% of that group managing between 21 and 30 diabetes patients in a typical week.

Variables from the "EMR Satisfaction, Effectiveness, Efficiency" constructs of the survey were selected as suitable measures of EMR usability and representative of EMR effectiveness, efficiency and satisfaction. These following variables were selected as potential dependent variables for this study:

#43 – I am confident that I will not lose my work if I make a mistake when using the EMR
#44 – The reports/searches that I can generate from the EMR are exactly what I need
#45 – I needed a lot of training before I felt confident using the EMR by myself
#46 – The EMR is cumbersome to use
#47 - The EMR has improved the quality of work in my practice
#48 - The EMR fits in well with my workflow
#49 - The EMR makes it easy for me to keep my patients' diabetes under control

A computation of Spearman's rank order correlation which determines relationships between the dependent variables was used to determine the significance of relationships among these variables. This non-parametric test was most appropriate for this small sample size. The results are presented in table 9.

The critical value for the non-parametric two-tailed test for the physician survey was set at the absolute value of .765 when α=.001. These values are based on the instrument presented by Zar (1972) [132] defining critical values of the Spearman's rank for two-tailed and one-tailed probabilities for small values of *n* (up to 100).

Table 9: Spearman's rank correlation coefficient for potential dependent variables

Spearman's rho (r_s) Listwise N = 16		43	44	45	46	47	48	49
43	Correlation Coefficient	1.000	.339	-.229	-.678	.630	.584	.664
	Sig. (2-tailed)	.	.199	.394	.004	.009	.018	.005
44	Correlation Coefficient		1.000	-.203	-.596	.690	.690	.690
	Sig. (2-tailed)		.	.451	.015	.003	.003	.003
45	Correlation Coefficient			1.000	.387	-.374	-.395	-.311
	Sig. (2-tailed)			.	.138	.153	.130	.242
46	Correlation Coefficient				1.000	-.701	-.695	-.695
	Sig. (2-tailed)				.	.002	.003	.003
47	Correlation Coefficient					1.000	.860	.860
	Sig. (2-tailed)					.	.000	.000
48	Correlation Coefficient						1.000	.946
	Sig. (2-tailed)						.	.000
49	Correlation Coefficient							1.000
	Sig. (2-tailed)							.

Based on the responses from the participants completing surveys, the computation of the Spearman's rank correlation coefficient for the 7 dependent variables selected 3 dependent variables meeting the specified threshold and which appear to reflect physician perceptions of EMR efficiency, effectiveness and satisfaction:

#47 - The EMR has improved the quality of work in my practice

#48 - The EMR fits in well with my workflow

#49 - The EMR makes it easy for me to keep my patients' diabetes under control

The level of training (#45) required to use the EMR confidently does not appear to have any significant bearing on physicians' perceptions of EMR efficiency, effectiveness or satisfaction, while fears of losing work if mistakes are made in the EMR is only slightly correlated with perceptions that the EMR is cumbersome to use. There also appears to

be a slight correlation between the searches that physicians generate from the EMR to obtain patient data (#44) and efficiencies in workflow and work quality and perceptions of proper control of diabetes in patients.

Spearman's rank correlation coefficient was then run between each of the three variables above (#47, #48, #49) and the other questions (independent variables) from each of the other constructs in the survey.

Table 10 shows the results of the correlation for the significant values set at the same threshold as before (absolute value of .765 when α=.001).

The sample size collected in the survey is not large enough for structured equation modeling or even a limited regression analysis. The assumption of normality is violated by such a small size and a more appropriate non-parametric analysis determining relationships between physician responses to the survey questions was employed instead.

Table 10: Spearman's rank correlation coefficient for dependent variables (47, 48, 49) and independent variables showing significant r_s values

#	Variables	r_s	Sig
47 The EMR has improved the quality of work in my practice			
68	I am able to easily add any new or additional flow-sheets and or stamps to the patient record based on their condition	.867	.001
69	I am able to obtain patient information from hospital reports directly through the EMR	.795	.003
84	I am able to adjust the existing prescription dosage using the EMR	.793	.004
48 The EMR fits in well with my workflows			
39	The EMR provides choice lists that are clear and unambiguous	.815	.002
60	The use of CPGs is important when managing patients with diabetes	.814	.002
68	I am able to easily add any new or additional flow-sheets and or stamps to the patient record based on their condition	.785	.004
69	I am able to obtain patient information from hospital reports directly through the EMR (eg. Use of EMR Download)	.773	.005
85	I am able to change the existing medications using the EMR	.789	.004
86	I sometimes find it difficult to manage medications in the EMR	-.843	.001
49 The EMR makes it easy for me to keep my patients' diabetes under control			
31	The EMR allows for different user roles in my practice	.771	.005
35	The EMR provides helpful information to help me use it better	.783	.004
37	The EMR provides clear warnings about drug interactions and allergies while I am working in a patient chart	.814	.002
61	I always apply the relevant CPGs when managing patients with diabetes	.814	.002
85	I am able to change the existing medications using the EMR	.789	.004
90	Using the EMR, I can show patients their historical progress with their condition	.864	.001
93	The EMR offers the ability for me to provide my patients with sick leave notes	.843	.001

Spearman's rank correlation coefficient for two-tailed tests, set at a threshold of absolute value of .765 when α=.001, determined that the most statistically significant relationships between the dependent variables representing EMR Satisfaction,

Effectiveness, Efficiency (EMR Usability), existed [positively] among three dependent variables. Specifically, physicians believe that the EMR complements their workflow in such a way as to produce improvements in work quality that impacts their ability to keep patient diabetes under control.

Because the three variables represented (#47, #48, #49) correlate so highly with one another, they were added together to obtain aggregate values for a new dependent variable representing "EMR Usability". Spearman's rank correlation coefficient was then run between this new dependent variable and the independent variables in each of the other constructs in the survey. Table 11 shows the results of the correlation for the significant values set at the same threshold as before (absolute value of .765 when α=.001). Table 12 shows the results of the correlation for other moderately significant values.

Table 11: Spearman's rank correlation coefficient for new dependent variable (EMR Usability) and independent variables showing significant r_s values

#	Variables	r_s	Sig
EMR Usability (aggregate of dependent variables #47, #48, #49)			
69	I am able to obtain patient information from hospital reports directly through the EMR	.803	.000
84	I am able to adjust the existing prescription dosage using the EMR	.797	.000
85	I am able to change the existing medications using the EMR	.792	.000
86	I sometimes find it difficult to manage medications in the EMR	-.793	.000
90	Using the EMR, I can show patients their historical progress with their condition	.839	.000

Table 12: Spearman's rank correlation coefficient for new dependent variable (EMR Usability) and independent variables showing moderately significant r_s values

#	Variables	r_s	Sig
EMR Usability (aggregate of dependent variables #47, #48, #49)			
31	The EMR allows for different user roles in my practice	.720	.002
33	I can customize certain default forms templates and reports in the EMR	.764	.001
39	The EMR provides choice lists that are clear and unambiguous	.657	.008
80	The EMR provides helpful information to help me make decisions about immunizations	.703	.002
81	The EMR provides helpful information to help me make decisions about treatment plans based on various risk factors	.748	.001

There are several significant findings from the analysis that reveal how EMR usability may affect physician work and workflow, the management of patients with diabetes, patient safety and overall patient health outcomes.

Physicians believe that the EMR complements their workflow and have caused improvements in the quality of work and likely the care provided to patients in their practice, based on:

- Their ability to customize charting in the EMR based on patients' conditions
- The ability of the EMR to access patient data directly from hospital reports presenting needed information at the point of care to aid in more timely treatments and maintaining patient safety
- Their ability to manage patients' medications in the EMR helping to reduce cognitive load and maintain patient health and safety

Additionally, complementary to their workflow is the use of the EMR in providing decision support to aid in diagnosis selection and support for clinical practice guidelines in managing patients with diabetes.

Physicians also believe that the EMR helps them keep patient diabetes under control by:

- Allowing for different user roles in the practice likely to help with coordination of care
- The presentation of information and the ease with which information may be obtained in the EMR helping to reduce cognitive load
- The availability of decision support in the EMR to provide alerts and warnings for drug interactions and /or allergies helping in maintaining patient safety
- The ease with which medications may be managed in the EMR aiding in maintaining patient health and safety
- The ability of the EMR to help the physician provide relevant information to patients using on-screen tools to support patient education and self management

EMR Usability regarding management of patients with diabetes appears to be tied to the ability of the EMR to allow physicians to obtain clinical information about patients from hospital reports – bringing relevant information to the point of care. It (EMR usability) also appears to be positively linked with the ability of the EMR to properly manage medications – addressing patient safety and proper diabetes control. Education and self management are also important care elements in diabetes care that seem to be positively linked with EMR Usability, as the data indicate that physicians value the ability to use the EMR to show patients important clinical data over time.

All physicians agreed that they use at least one of these functions (Reminders, Searches, Chronic Disease Modules, Flow-sheets, Stamps) in the EMR to help them adhere to clinical practice guidelines for the management of patients with diabetes. Additionally 81% of them felt that using functions in the EMR that helped them better adhere to Clinical practice guidelines helped them better manage patients with diabetes.

6.1.1. Physician Comments – Use of EMR to Manage Diabetes

In addition to data gathered from responses to the structured statements in the survey, participants were invited to enter unstructured comments regarding their use of their EMR in managing patients with diabetes and /or their satisfaction with their EMR - 75% of participants entered comments which added qualitative data to enrich the content of the study. The participant comments follow. Any mention of a specific EMR by participants has been replaced with [my EMR].

- "Lablink just recently been made available for my EMR which will improve things".
- "Best tool for Chronic Disease Management; I can play with it to customize it the way I like".
- "The EMR is a tool, however it is critical to remember that the patient is still the major source of information about his/her condition - we are only providing advice and consultation. "Easier" to get information is NOT always a "Better" way to get information. Too much gazing at a computer and not enough directly engaging with the patient leads to poor care".
- "Thinking about using patient portal would like to be able to fax script from EMR but not possible yet; very satisfied with it, have had [my EMR] since 2000".
- "Using EMR lists for overdue f/u [follow-up] K030 and Q040 immunization updates and ophthalmology yearly f/u [follow-up]".
- "No ability to use emr to manage populations, we have manual (excel) registries and a variety of other work arounds".
- "We have just gone 'live' with our EMR for charting and referrals. We are in the process of adopting specific flowsheets for DM"
- "Much of the recommendations in Diabetes CPGs are based of "expert opinion" and not Grade A evidence so hard to know what applies to Family Medicine. For example being told to aim for HbA1C of 6% in T2D then studies show this increases mortality".

- "Stamps are useful during diabetic visits, but would be good to have a DM flowsheet developed".
- "Some of the difficulty in information retrieval arises from inconsistent entry (non standardized nomenclature)".

6.1.2. Physician Comments - Satisfaction with EMR

- "We are just in the process of moving to a completely new version of this software. My opinions were based on version 4 software".
- "Drug interaction - drug- drug and drug-condition interactions are overdone to the point of alert fatigue".
- "It is excellent particularly because it is designed to meet the needs of family practice".
- "I hate my emr and am trying to get my 11 years of data migrated to another one but no far not much progress".
- "Transition has been fairly good with most clinical features. Working on hospital interface for importation of labs, reports".
- "Wish I had switched to EMR 20 years sooner"
- "Very satisfied"
- "Generally I like [my EMR] - the medication interaction piece is overly aggressive, and we need a standardized flowsheet for Type 2 Diabetes"

6.2. Nurse Survey

Invitations to participate in the study were sent to a total of 30 primary care nurses, of which only 5 participated and completed the online survey. Due to the low response rate (16.6%), the data provides no statistical validation and thus cannot be used to draw any specific conclusions regarding EMR usability, but however may be used to enhance the study information. Reasons for the low response rate may include:

- Initial technical problems with LimeSurvey – within 48 hours of sending out initial survey invitations to physicians and nurses, seven physicians sent emails indicating that they were not able to access the survey. Although the problem was later rectified by McMaster support staff, there is no telling how many persons, including nurses, experienced problems and did not bother to again try to complete the survey.
- Busy schedules – contact with some practices to solicit participation from nurses indicated that many nurses were just too busy to complete the survey.

An attempt was made to summarize the information and represent nurses' opinions without author bias. Any insertion of author opinions or comments in the following summary is indicated in "*(parenthesized and italicized text)"*. Where applicable, participants' comments are prefaced by *Comment:* and followed by "quoted" text. Specific mention of EMRs in comments has been replaced with [my EMR].

All of the participants were registered practical nurses, except for one who, at the time of the survey was a nurse practitioner. In this paper registered practical nurse and nurse practitioner will be referred to as nurse. Three of the participants had been in their present occupation for up to 10 years, and 2 for over 10 years. Regarding patient care, all the participants indicated that they consulted with less than 20 patients per day except for one who consulted with up to 30 patients per day. Regarding diabetes

patients, all the participants indicated that they consulted with fewer than 20 diabetes patients in a typical week except for one who managed up to 30 diabetes patients per week. Although one participant did not respond to the length of time that a consultation with a diabetes patient typically lasts, three indicated that they spend up to 30 minutes with each diabetes patient, while one spends less than 15 minutes with a [diabetes] patient. All participants completing the survey are currently using an EMR to manage patients in their practice, and all but 1 participant used an EMR from a common vendor.

Making appointments for patients:

All participants agreed that it was easy to make appointments for patients using their EMRs.

(Appointment scheduling – one of the first points of contact with patients – is important in ensuring that patients receive required care when it is needed. Difficulty in scheduling may indicate disruptions in office workflow and the possibility of patients getting overlooked / bypassed for care, resulting in reduced health outcomes).

Sending blood screen order to local lab:

While none of the participants were able to send orders for lab tests directly (electronically) from the EMR to providers *(orders may be faxed or paper orders given to patients to get tests done)*, all but one participant indicated that their office initiated lab orders from custom forms within the EMR – the participant not using custom forms within the EMR used hard copy paper forms stored in the office to get lab orders done; this participant also used a different EMR from the rest. *(The ability to initiate lab orders from custom forms stored within the EMR saves time and reduces errors arising from incorrect patient data being attached to hand-written orders. Additionally, the availability of electronic forms helps reduce the paper burden of stored forms within offices – which has implications for efficiencies in time and resource management and reduced costs).*

Review of patient record:

Regarding reviews of patient records, there was a consensus from all participants that they were able to get a quick snapshot of patients' health status as well as specific demographic information from the EMR. Additionally, test results were downloaded into the EMR directly from providers and results and procedures were clearly identified. *(The ability to quickly see pertinent information in clinical records aids in reducing the number of items/tasks that the user has to remember - cognitive load - and addresses other usability principles of simplicity, naturalness and efficient interactions).*

Preparations prior to physician seeing patient:

Although all participants agreed that they follow a standard format when charting information for patients with diabetes, one participant indicated that the layout for the standard diabetes template was cumbersome and did not easily show patient information over time that could be used as comparisons to guide patient care. *Comment:* "I found the layout of the DM flow chart in [my EMR] to be cumbersome and did not provide comparative columns at a glance for patient values unless you engaged a new and separate prompt"*.*

(Having a standard format to follow aids in routine task completion, reduction in cognitive load and adherence to clinical practice guidelines. However the inability to easily compare previous lab test or other values indicates that the user has to employ extra mouse clicks or screen changes to obtain the required information, resulting in time consuming behaviours that have the potential to negatively affect patient care and possibly compromise patient safety).

Updating the patient record:

All participants agreed that it was easy to update EMRs with information before the physician consulted with the patient. Additionally, the EMR allowed them to enter information in pre-defined spaces during chart update. All participants agreed that their

EMRs were automatically able to calculate patient body mass index (BMI) based on height and weight measurements input into the chart. *(With as little time as possible being spent on chart update, information has to be well presented and easy to interact with in ways that require little cognitive effort to achieve accurate task completion. The availability of decision support to aid with task completion helps save time and effort and minimizes errors – ensuring patient safety, task effectiveness and increasing workflow efficiencies).*

Consultation with patient:

While all participants indicated that they updated the EMR during consultations with patients, they also indicated that they do not spend too much time looking for or updating information in the patient chart. One participant indicated that the EMR causes distractions when consulting with patients.

(Distractions caused by the EMR may hinder the social interaction with patients in ways that may cause mis- or non-communication of information, negatively affect the face-to-face encounter and jeopardizing patient care).

All participants except one were able to provide material to patients from handouts obtained directly from the EMR.

(*This limited availability of information via the EMR may either prompt a user to seek out other sources of information – which not only may be time consuming but also may cause disruptions in workflow – or may put the patient at a disadvantage of not receiving relevant care materials that may aid in self-management activities*).

Satisfaction with EMR:

Participants agreed that the EMR made it easy to keep their patients' diabetes under control, and that using the EMR helped to provide a more efficient patient encounter and also helped them to better manage their population of patients with diabetes.

(Nurse consultation with patients and use of EMRs was centered around the completion of routine physician pre-consultation activities and the provision of information to aid in the physician-patient consultation. These activities are generally quick and as little time as possible is spent on chart update. Information thus has to be well presented and easy to interact with in ways that require little cognitive effort to achieve task completion).

6.2.1. Nurse Comments

In addition to data gathered from responses to the structured statements in the survey, participants were invited to enter unstructured comments regarding their use of their EMR in managing patients with diabetes and /or their satisfaction with their EMR - 3 participants entered comments which added qualitative data to enrich the content of the study. The participants' comments follow. Any mention of a specific EMR by participants has been replaced with [my EMR].

- "[My EMR] is a very user friendly product. It has some limitations but once familiar with it there is an intuitive sensibility that develops. Now being familiar with other EMRs I find I appreciate [my EMR] even more!"
- "Lab requisitions are generally not sent to the lab prior to the patient's arrival. Most patients are given the requisition to take with them to the lab as patients are free to use a lab of their choice. I found the layout of the DM flow chart in [my EMR] to be cumbersome and did not provide comparative columns at a glance for patient values unless you engaged a new and separate prompt".
- "I have only been in a family practice for 11/2 years. Before I was in a Long-term care facility with only paper charts. As I become more proficient with use of the EMR I am more and more impressed".
- "I am new to family practice and have only used [my EMR] and for diabetes management, I feel that it is effective".

6.3. Dietitian Interviews

The following section summarizes comments gathered during interviews with 5 dietitians in primary care. The comments have been paraphrased, with an attempt at presenting information that is relevant to diabetes patient care and that is influenced by EMR usability, but which may not have been emphasised in the physician or nurse surveys. Although the summaries are based on a small sample size and are not validated, they provide valuable information that may be used to guide further research into EMR usability (and use) regarding the care of patients with other chronic diseases. An attempt was made to summarize the information and represent dietitian comments and opinions without author bias. Any insertion of author opinions or comments in the following summary is indicated in "*(parenthesized and italicized text)"*.

Three dietitians described themselves as being very computer literate or adequately technology savvy and said that were provided with very little or no training in using the EMR - their use of functions within the EMR was mostly self-taught, aided by whatever documentation was available in the EMR itself and occasional help by another user in the office. At the time of their interviews, one of two different vendor EMRs were being used by each participant, with one participant using both vendor EMRs. In general, they were in agreement that their EMRs are very effective and useful in managing the care of patients with diabetes, but they felt that these electronic tools were not being used to their full potential – not just by the dietitians themselves, but also by the teams within which they operate. Reasons provided for this were the availability (or lack thereof) of information that may be obtained from the EMR, the format of various information presented to the user, the cumbersome manner in which some information may be obtained, and the user's limited training in using certain aspects of the EMR.

6.3.1. Case Scenario

The dietitians were presented with the following case scenario and questions aimed at helping them describe their interactions with the EMR in managing patients with diabetes.

Consultation with patient with chronic Type 2 Diabetes

An obese patient with consistent elevated LDL, chronic hypertension and type 2 diabetes is referred to you for a consultation after having been to his primary care physician. Latest values for the patient's vital signs, weight, fasting blood sugar, lipid panel and HbA1c have been recorded in the EMR. Additionally, a diabetic foot exam was performed in his physician's office at his last visit.

Please describe the following:

1. How do you get the information regarding the referral for the patient
2. What kind of information about the patient is provided to you
3. How is clinical information about the patient made available to you
4. How is an appointment made for you to consult with a patient
5. How do you manage patients with diabetes – making specific reference to your use of the EMR (if any) to assist you in this process.

Because each participant was given full access to all information contained in the patient chart in their EMR, questions 2 and 3 have been combined in the following summary.

Getting information regarding the referral of the diabetes patient:

The dietitians' EMRs provided a scheduling and/or messaging function via which they were alerted of a diabetes patient referral - the patient chart was accessed through the schedule or message, and it was the responsibility of the user to check the schedule or messages regularly.

The nature of the information about a diabetes patient that was provided, and the manner in which the information was made available to the dietitian:

The participants indicated that once a referral of a patient was made to them and they accessed a patient's chart, they had full access to all clinical information regarding the patient. This would include demographic information, the cumulative patient profile, problem lists, chart notes, laboratory test results, medication lists, and any other information available in the electronic chart.

The process by which appointments were made for the dietitian to consult with a patient:

The process by which appointments were made for the dietitians to consult with the patient with diabetes was initiated when the physician or nurse sent information regarding the request for referral to administrative staff or when a patient called in to make an appointment to consult with the dietitian. If the request was initiated by the physician or nurse, the patient was then called by the administrative staff to schedule the appointment, and then a message was sent to the dietitian via the EMR or the dietitian schedule was updated in the EMR informing of the pending appointment with the patient. One participant commented that when the onus of making the appointment was placed on the patient, the majority of the time the appointment was never scheduled (because the patient never called in) unless the dietitian followed up by calling the patient. Dietitian's teams either used the EMR to electronically route the request for referral from the physician or nurse to the administrative staff or relied on using a standard hard-copy paper referral sheet.

Management of patients with diabetes – specific reference to dietitian use of the EMR:

The dietitians described the management of their patients with diabetes using several activities that began with reviewing the patient's electronic chart before the consultation.

During the consultation the use of a structured charting process was employed which entailed:

- Verification of information with the patient regarding current health status and recent tests performed
- Review of trends and targets with patients on and/or off screen
- Review of previous goals that had been set and setting new goals with patient
- Performance of screening tests (like depression) and preventative care (like immunizations) for further follow-up with other team members
- Performance of diabetic foot exam
- Use of custom forms to make referrals for further tests or consultations with specialists
- Provision of relevant informational and educational material to patients to aid in self management activities

At the time of the interview, participants completed responses to 11 demographic and other questions regarding their own particular situations, as well as 4 categories of questions relating to their review and update of the electronic patient chart, their consultation with patients and their satisfaction with the EMR.

6.3.2. Review of Patient Record

While the participants agreed that they always review the patient chart before the consultation and could quickly get specific demographic information from the EMR, the participant who used two different EMRs indicated that it was not easy to identify or get information regarding lab test and procedures that were performed from one of the EMRs, and another participant indicated that it was not as easy to get a quick snapshot of a patient's health status using the EMR. *(Difficulty in obtaining/locating information from/in the EMR would indicate that information may be available only after several clicks or screen changes, and that more time has to be spent searching for relevant patient information, disrupting workflows, increasing cognitive load, causing ineffective*

interactions, compromising patient care and safety, and highlighting the lack of simplicity and naturalness that is expected through good application usability).

6.3.3. Electronic Chart Update

Following a standard format - structured charting - when updating information for patients with diabetes in the EMR was the consensus of the dietitians, and one expressed satisfaction with being able to create customized templates that were based on information obtained from clinical practice guidelines, existing custom forms, and clinical experience for use during consultations. However one dietitian, while using a standard nutrition assessment, followed this on paper or from experience first before later transferring the information to the EMR. Regarding a specific EMR, two participants disagreed that it was easy to update the patient record with information obtained during the consultation with the patient. One of these participants also indicated that more than 20 minutes was spent on data entry and documentation during and after each patient consultation. *(Having a standard format to follow aids in routine task completion, reduction in cognitive load and adherence to clinical practice guidelines, however difficulty in chart update could indicate a level of cumbersomeness that could have the potential to cause inadequate chart completion, resulting in inadequate patient care and possibly compromising patient safety)*.

A concern for dietitians was the lack of adequate decision support to effectively manage allergies in the EMR. *(Having adequate decision support in an environment where patients may be on multiple medications and specific diets is important in minimizing cognitive load of clinicians and in maintaining patient safety).*

6.3.4. Patient Consultation

The dietitians agreed that they performed pre-consultation activities that allowed them to tailor each consultation to each patient with diabetes. All but one dietitian indicated that they spent over 30 minutes with a patient with diabetes during a consultation (one dietitian consultation typically lasted between 15 and 30 minutes), and while three were able to provide relevant material to the patient from handouts stored in the EMR, two participants indicated that the availability of information/handouts in a particular EMR was limited and that often times they sought out materials from the internet. One dietitian did not use handouts stored in the EMR, but rather used pre-printed paper copies of educational materials stored in the office or obtained from other sources. (*This limited availability of information via the EMR may either prompt a user to seek out other sources of information – as was done - or may put the patient at a disadvantage of not receiving relevant care materials. Additionally, not using the EMR to provide educational material may indicate difficulty in accessing that function in the EMR or a lack of user training in completing such tasks*).

One dietitian expressed satisfaction with being able to construct and perform customized searches/queries within the EMR that helped with finding useful information regarding particular patients or groups of patients. *(The ability to easily produce required reports from customized queries is useful in decision making and in minimizing cognitive load of clinicians while managing patients).*

The dietitians disagreed that the EMR distracted them during their consultations with patients. (*Based on their comments, the EMR was used very little during the consultation either because they preferred to have a more personalized face-to-face encounter, or because using the EMR was cumbersome and would severely hinder the face-to-face encounter*). Two dietitians using a specific EMR usually updated the EMR during consultations. One of these indicated that doing this enhanced the encounter as

it was helpful and welcomed by patients to show them information regarding their health on-screen. This same dietitian, commenting on using another EMR indicated that because it was so cumbersome to find and update information in the [other] EMR, it was easier and less stressful during the face-to-face encounter to handwrite notes and later update the EMR once the consultation was completed. Three participants indicated that the layout of the room sometimes made it difficult to interact with the EMR during a consultation, as that would have meant having to turn one's back to the patient. *(While the room layout may have enhanced the face-to-face encounter with the patient, the placement of the computer screen detracted from the opportunities to educate and inform patients using on-screen tools. This would also indicate that material that could have been easily shown on-screen to patients may have been made available via printed copy, or perhaps that information may not have been shared with the patient at all)*.

6.3.5. Satisfaction with the EMR

All but one dietitian using a specific EMR agreed that the EMR made it easy to keep their patients' diabetes under control, and that using the EMR helped to provide a more efficient patient encounter and also helped them better manage their population of patients with diabetes. *(Despite shortfalls in usability of their EMRs and lack of training in the use of the tool, the dietitians, likely because of their level of computer literacy and technology savviness, were able to use the EMR in ways that enhanced their care of patients with diabetes. One dietitian described it as being a definite step up from using paper charts)*.

The same dietitian expressed dissatisfaction with a particular EMR – due to cumbersomeness in design and lack of intuitiveness in information retrieval and presentation - in helping to provide an efficient encounter and keeping patients' diabetes under control *(User interfaces that lack sufficient context preservation and that do not maintain consistency in screen changes and with other applications are awkward*

in information retrieval and presentation, and lack the usability necessary in clinical applications to aid in efficient workflows and in enhancing the quality of care provided to patients).

6.3.6. Dietitians Other comments

Participants were also asked to provide any additional information regarding their use of the EMR in managing diabetes and their satisfaction with the EMR.

One dietitian expressed concern at the emerging requirements for the use of *International Dietetics Nutrition Terminology* - standardized nutrition language that reflects the nutrition care process - within the profession, that is aimed at developing and enhancing nutrition practice, education, research and policy [131]. The concern was centred around the EMR in its present capacity to accommodate the *International Dietetics Nutrition Terminology*, and the implications for compliance (or non-compliance) within the profession. Another dietitian felt that unless the new *International Dietetics Nutrition Terminology* included the use of *International Classification of Disease* (ICD) or *Systematized Nomenclature of Medicine* (SNOMED) coding familiar to EMRs, its assimilation into patient care would be problematic and counter-productive to quality patient care. Two other dietitians shared a similar view, expressing that there would be no benefit in incorporating the *International Dietetics Nutrition Terminology* into EMRs if its use would only be applicable to dietitians.

Another dietitian expressed interest in controlling the case management for specific initiatives surrounding diabetes management, but indicated that more training would be required in order to be able to use the EMR to effectively and efficiently support such activities.

The dietitians expressed satisfaction in the appropriate placement of on-screen elements in their EMRs, saying that although sometimes dialog boxes and prompts seemed a bit excessive (and seemed even more so once one was used to working in the application) action buttons were quite visible and easy to access during use of the EMR.

Themes common to each dietitian interview included the use of the EMR to help in the management of lifestyle counseling and patient education regarding self-management of diabetes, the use of standard/structured charting processes, and use of the EMR for coordination of care with other health care professionals.

The dietitians expressed the importance of patient education and self-management, and having aids available to support these initiatives. They appreciated the ability of the EMR to trend certain data over time – a useful component to help with patient goal setting. While most were satisfied with their EMR's ability to graphically represent trends over time, one dietitian indicated that that functionality in a particular EMR was crude and inadequate as there was significant data that was excluded from trending patterns. While they were satisfied that the EMR had the ability to store relevant educational material which could be given to patients to aid in self-management, one participant indicated that the availability of information/handouts in the EMR was limited. Additionally, one participant suggested that a patient portal which would allow direct communication with patients would enhance the care that is provided and improve self-management initiatives.

Because of the complex nature of diabetes and its multiple care components, the dietitians recognized the usefulness of following standard/structured formats in charting and consultation. The use of templates that are based on information obtained from clinical practice guidelines, existing custom forms, and clinical experience help guide the

charting and consultation process and make for a more efficient patient experience and overall improvement in patient care. Additionally the use of reminders to help maintain schedules for routine and preventative screening tests and treatments were identified as important tools to manage diabetes patient care.

The importance of coordination of care with other clinicians for effective management of diabetes in patients was highly stressed by the dietitians and they expressed concern that their teams may not be using the EMR to its full capacity to manage coordination of care of patients. One of the dietitians expressed concern that charting in the EMR was being done more to avoid legal consequences rather than to manage patients and coordinate care. *(EMRs have the potential to improve the coordination of care through the ready availability of patient information at the point of care, and may improve patient safety and medical outcomes, and decrease medical costs).*

7. LIMITATIONS AND FUTURE RESEARCH

The main limitation of this project is the small sample size of each group which does not serve to validate the research, but it did provide insightful information into the effects that EMR usability may have on the management of diabetes.

A second limitation is the inability to objectively assess the effect that EMR usability has on clinical decision making, coordination of care, adherence to clinical practice guidelines, efficiency of workflows, patient safety and the overall management of diabetes and resulting health outcomes in individuals.

This small study could be used to guide further research into EMR interface design or enhancements and to support EMR certification processes and/or a comparative analysis of two or more EMRs that would guide the EMR selection processes. With data from larger samples completing both the physician and nurse surveys, the models presented could be verified through a reliability analysis. Additionally, using structured equation modeling (SEM) evaluation through Partial Least Squares (PLS), both models may be properly validated. A larger sample size for the dietitian interview data would benefit from a qualitative analysis through *NVivo* coding that would identify relationships in the unstructured data.

Although this study focused on EMR usability regarding the management of diabetes care, it may be modified to include the management of other chronic disease. However further research will be required to identify deficiencies in the management of specific chronic conditions for which care guidelines are not as clearly delineated as that of diabetes. Additionally, the focus may be streamlined to address the effects of EMR usability on specific activities such as clinical decision making, coordination of care, patient safety and/or workflows in particular settings.

8. DISCUSSION AND CONCLUSIONS

The management of diabetes in individuals require evidence-based care elements and treatments that improve quality of care and maintain safety in individuals, and reduce health care costs throughout the system. EMR use has been documented to bring care guidelines to the point of care, to provide prompts and reminders for clinicians to apply specific interventions to control acute and chronic diseases and to help organize patient information in ways that make for easy retrieval and reporting of information, creation of registries, reliable medication monitoring, coordination of care and planning for quality improvement programs. Decision support integrated into these electronic tools helps deliver evidence-based care and promotes the application of timely interventions that improve processes of care and health outcomes in individuals. Poor EMR usability has resulted in poor adoption rates, underutilization of systems, inability [of EMRs] to provide quality improvements in health care and endangerment of patient health.

Clinical practice guidelines for the management of diabetes in individuals specify the support of care with an integrated, multi- and interdisciplinary group of health care professionals, normally referred to as the Diabetes Health Care (DHC) team [24]. In addition to a family physician and/or specialist, the core DHC team also includes a nurse and dietitian. With the rapid increase in the number of EMR vendor applications and the push from the Government of Ontario / MoHLTC for the widespread adoption of EMRs in the province, these stakeholders, no doubt, will play increasingly important roles in determining how EMRs are used to manage diabetes patient care (and chronic disease care in general). For this reason it is important that EMR usability be identified as a significant dynamic in providing quality improvements in health care while improving patient safety and health outcomes. Likewise, EMR vendor roles in usability of

applications they provide, to an extent, determines adoption (and by extension patient care) and should be guided by usability research and testing.

EMR specifications outlined by OntarioMD have been used to define the meaningful-use criteria of EMRs in Ontario, and include several mandatory baseline requirements that support Practice Management and Clinical Support, while strengthening chronic disease management of patients and care delivery [63]. Except for Services Billing, these meaningful use criteria were used as evaluation metrics for EMR usability in either of the physician and nurse surveys or the dietitian interviews. They include:

- Entering encounter notes for patients seen
- Entering problem lists for patients seen
- Making new prescriptions / renewals
- Generation of automated alerts / reminders to support care delivery
- Receipt of lab results electronically, directly into the EMR from private labs supported by the EMR Specification
- Storage of patient care related information and documents within the EMR that originated from another healthcare provider or organization
- Patient appointment scheduling
- Services Billing

Figure 8 presents a *Use Case* diagram that represents the diabetes care and stakeholder components associated with the management of diabetes in individuals in the primary care setting, while figure 9 presents a workflow diagram that represents the workflow and interactions between care providers for the management of diabetes in the same setting.

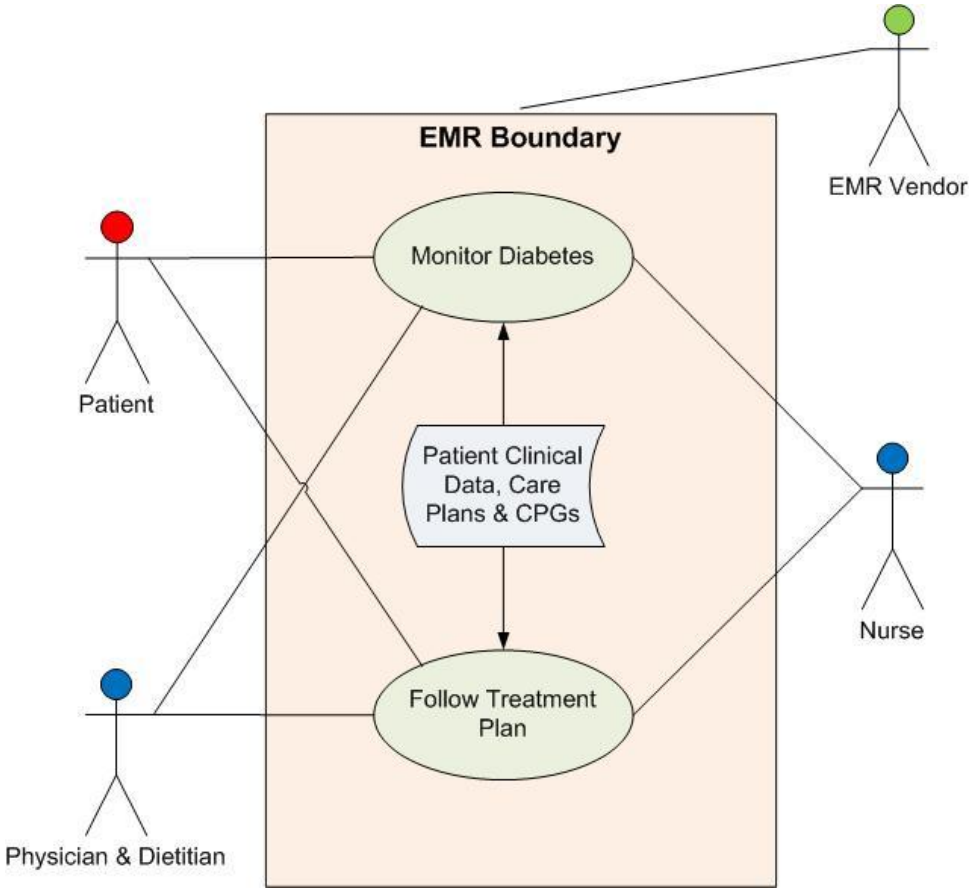

Figure 8: Diabetes Care and Stakeholder Components *(Adapted from AHRQ EHR Usability Evaluation and Case Framework)* [104]

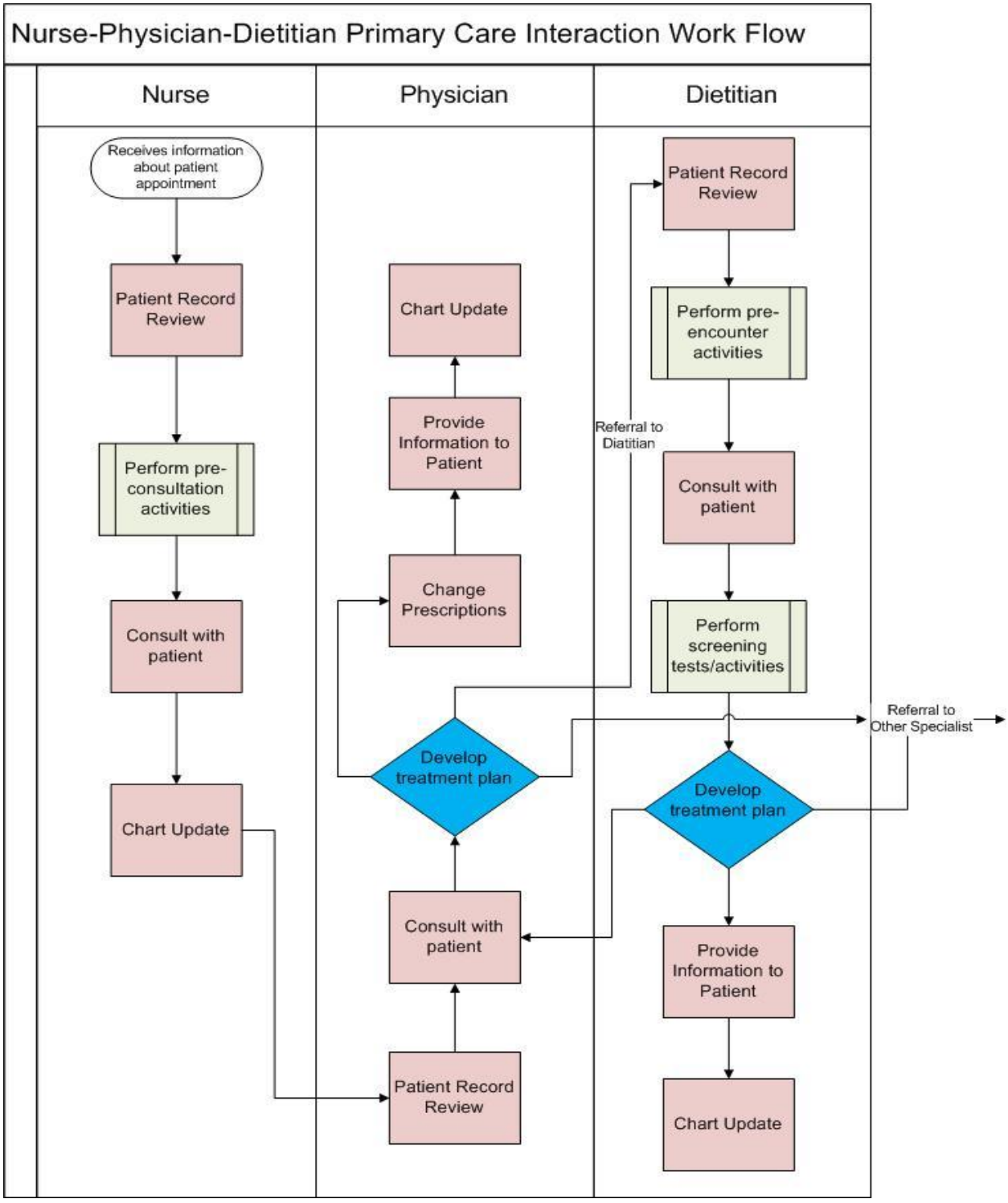

Figure 9: Nurse-Physician-Dietitian Interactions Flowchart

Although slight modifications to the use case and workflow diagrams may have to be made to represent stakeholders, both diagrams may be adapted to the management of most other chronic diseases in primary care.

Although this study gathered a limited amount of data, the findings provide useful information that may be used to guide future research into EMR interface design or enhancements and to support EMR certification processes and/or a comparative analysis of two or more EMRs that would guide the EMR selection processes. The findings are summarized separately for physicians, nurses and dietitians.

8.1. Physicians Summary

Although the sample size obtained for the EMR usability study regarding physicians in primary care allowed for limited analysis of the data, relationships were still able to be determined, and there are several significant findings from the analysis that reveal how EMR usability may impact physician work and workflow, the management of patients with diabetes, patient safety and overall patient health outcomes.

In general, physicians believe that the EMR complements their workflow and have caused improvements in the quality of work and likely the care provided to patients in their practice, based their ability to customize charting in the EMR, the availability of patient data from external sources like hospital reports and their ability to properly manage patient medications with the EMR. Additionally, complementary to their workflow is the ability of the EMR to provide decision support that aids in diagnosis selection and support for clinical practice guidelines in managing patients with diabetes.

To help them to keep patients' diabetes under control and ensure patient safety, physicians see value in the ability to properly manage medications in the EMR and feel that the presentation of information and the ease with which it may be used are

important elements in EMR usability. In addition, there is value in the EMR's ability to coordinate care and maintain patient safety through the accommodation of different user roles and the availability of decision support to provide alerts and warnings for drug interactions and /or allergies. Adding to their arsenal in keeping patient diabetes under control is the ability of the EMR to help them provide relevant information to patients using on-screen tools that support patient education and self management.

8.2. Nurses Summary

Due to the low response rate from the nurse survey, the data provide no statistical validation and thus cannot be used to draw any specific conclusions regarding EMR usability, but it may be used to enhance the study information. Nurses' consultation with patients and use of EMRs was centred around the completion of routine physician pre-consultation activities and the provision of information to aid in the physician-patient consultation – verification of the availability of lab results, charting patient vital data and updating pertinent health status information – and not much too much time was spent on the chart updating process.

Nurse activities are generally quick and as little time as possible is spent on chart update. Information thus has to be well presented and easy to interact with in ways that require little cognitive effort to achieve task completion. The nurses valued the ability to use pre-defined fields and standard formats in updating chart information and felt that having the ability to see certain patient data through time (trending) was important – this functionality likely provided efficiencies in managing their workflows.

The nurses agreed that the EMR made it easy to keep their patients' diabetes under control, and that using the EMR helped to provide a more efficient patient encounter and also helped them better manage their population of patients with diabetes.

8.3. Dietitians Summary

An analysis of the limited data collected through interviews with dietitians revealed that despite shortfalls in usability of their EMRs and lack of training in the use of the tools, the dietitians were generally satisfied with their EMR interfaces in helping to keep their patients' diabetes under control. A possible explanation for this could be their level of technology savviness and computer literacy. They also thought that the way in which the EMR was used helped to provide a more efficient patient encounter and also helped them better manage their population of patients with diabetes.

Although access to graphical tools that helped trend patient data was important in helping patients visualize their conditions and support self-management initiatives, the dietitians generally limited their use of the EMR during patient consultations and focused more on maintaining a patient-centred face-to-face encounter. These participants stressed the importance of interface design intuitiveness in information retrieval and presentation in making efficiencies in routine task completion to minimize cognitive load, ensuring adherence to clinical practice guidelines, maintaining efficiencies in workflows and patient safety and enhancing patient care and health outcomes.

Three main themes emerged from the interviews with the dietitians. Much emphasis was placed on the ability of the EMR interface to:

- provide standard/structured formats in charting and consultation. The use of templates that are based on information obtained from clinical practice guidelines, existing custom forms, and clinical experience help guide the charting and consultation process and make for a more efficient patient experience and overall improvement in patient care.

- help manage lifestyle counseling and patient education regarding self-management of diabetes. The availability to provide relevant educational material and presentation of clinical data through graphical tools help support self-management and lifestyle activities that enhance patient care and health outcomes.
- properly incorporate the management of patient coordination of care with other health care professionals into care and treatment plans. EMRs have the potential to improve the coordination of care through the ready availability of patient information at the point of care, and may improve patient safety and medical outcomes, and decrease medical costs.

The objectives of this study were to investigate the use of EMRs in managing diabetes within primary care in Canada, and to evaluate their usability, with special reference to health care provider workflow, adherence to clinical practice guidelines and patient safety in managing diabetes in individuals. These objectives were intended to prompt analysis of the research question "Should EMR usability within primary care be considered a significant dynamic in the effective management of diabetes in individuals?"

This study has identified a partial answer to the research question, which is that among certain health care professionals – particularly physicians and dietitians - EMR usability appears to play an important role in improving work quality and patient treatment plans as well as care monitoring for individuals with diabetes. Specifically, EMR usability regarding diabetes patient care appears to affect clinician workflows, patient education and self-management support and coordination of care within the primary care setting. Additionally, EMR usability appears to impact patient safety and overall care through the adherence to care plans and clinical practice guidelines, and the proper management of medications.

In order to make these findings more convincing, more data needs to be collected and more research needs to be conducted to validate models of EMR usability as well as to objectively assess the effect that EMR usability has on clinical decision making, coordination of care, adherence to clinical practice guidelines, efficiency of workflows, patient safety and the overall management of diabetes and resulting health outcomes in individuals.

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Appendix A

McMaster University

Inspiring Innovation and Discovery

McMaster University Research Ethics Board (MREB)

c/o Office of Research Services, MREB Secretariat, GH-305, e-mail: ethicsoffice@mcmaster.ca

CERTIFICATE OF ETHICS CLEARANCE TO INVOLVE HUMAN PARTICIPANTS IN RESEARCH

Application Status: New ☐ **Addendum** ☐ **Project Number:** 2011 075

TITLE OF RESEARCH PROJECT:

Electronic Medical Records Interface Design Considerations for Improving Outcomes in Diabetes Management in Primary Care: A Usability Study

Faculty Investigator (s)/ Supervisor(s)	Dept./Address	Phone	E-Mail
N. Archer	Business	23944	archer@mcmaster.ca
Student Investigator(s)	**Dept./Address**	**Phone**	**E-Mail**
U. Fevrier-Thomas	Business	905-538-6041	fevrieui@mcmaster.ca

The application in support of the above research project has been reviewed by the MREB to ensure compliance with the Tri-Council Policy Statement and the McMaster University Policies and Guidelines for Research Involving Human Participants. The following ethics certification is provided by the MREB:

☐ The application protocol is approved as presented without questions or requests for modification.

☐ The application protocol is approved as revised without questions or requests for modification.

☑ The application protocol is approved subject to clarification and/or modification as appended or identified below:

COMMENTS AND CONDITIONS: Ongoing approval is contingent on completing the annual completed/status report. A "Change Request" or amendment must be made and approved before any alterations are made to the research.

Application is approved based on the changes that have been submitted.

VL

Reporting Frequency:	Annual:	Other:

Date: May 30/11 Chair, Dr. D. Maurer/ Vice-Chairs, Dr. Tina Moffat & Dr. Bruce Milliken:
Violetta Lyneski Acting Vice-Chair

Appendix B

Percentage of Family Physicians by Remuneration Model in Ontario [133]

	Type of Remuneration Model	
	Fee For Service (FFS) %	Alternative Provider Remuneration Model (APRM) %
Physicians in Ontario	64.63	35.37
Physicians in Canada	58	42

The province offers salaries to community family physicians, as well as blended APRM. All APRM are associated with innovative service delivery models. Salaries are offered in Community Health Centers that provide interdisciplinary care to high risk and vulnerable populations.
Blended funding is offered through a series of health care delivery models, including:

- Comprehensive Care Model (CCM)
- Family Health Group (FHG)
- Family Health Networks (FHN)
- Primary Care Networks (PCN)
- Family Health Teams (FHT)
- Health Services Organizations (HSO)
- Rural and Northern Physician Groups (RNPG)

The CCM and FHG offer a rostering fee per patient in addition to regular FFS billings. The FHN, PCN, and HSO offer a capitation payment for the delivery of a basket of services, and additional FFS billings for services outside the basket.

Appendix C

Ontario LHIN Coverage [9]

Map of LHINs in Ontario

1. Erie St. Clair
2. South West
3. Waterloo Wellington
4. Hamilton Niagara Haldimand Brant
5. Central West
6. Mississauga Halton
7. Toronto Central
8. Central
9. Central East
10. South West
11. Champlain
12. North Simcoe Muskoka
13. North East
14. North West

Each LHIN's Accountability Agreement and Annual Service Plan are available on the LHIN web site at :

http://www.lhins.on.ca/page.aspx?id=1236&ekmensel=e2f22c9a_72_446_btnlink and
http://www.lhins.on.ca/page.aspx?id=1414&ekmensel=e2f22c9a_72_448_btnlink respectively.

Appendix D

Main Components of Primary Care Delivery Models in Ontario

Adapted from Olsen et al., Health System Intelligence Report; Health Human Resources Toolkit. HealthForceOntario [6]

	Introduced	Composition	Characteristics	Physician Compensation Model	Interprovider Compensation Model	Roster
Comprehensive Care Model (CCM)	October-05	Solo physicians	• Only 3 hour block of after-hours services per week • Patient enrolment required	• Fee-for-service based plus after-hours premiums • Additional payments for delivering targeted preventative care services • Monthly comprehensive capitation payments for enrolled patients	Not Applicable	351 physicians 412,275 enrolled patients
Family Health Groups (FHG)	2003	Groups of three or more physicians	• Regular and extended hours • One 3 hour block of afterhours service per physician per week up to a maximum of five blocks • Nurse-staffed Telephone Health Advisory Service (THAS) • Patient enrolment is voluntary but some premiums are only paid for enrolled patients	• Fee-for-Service plus afterhours and comprehensive care premiums and bonuses • Additional payments for delivering targeted services to patients. • Monthly comprehensive care capitation payments for enrolled patients	Not Applicable	333 groups 4,479 physicians 4,840,803 enrolled patients

Family Health Networks (FHN)	2001	Groups of three or more physicians	• Regular and extended hours • Nurse-staffed THAS • Patient enrolment required	• Blended capitation model • Additional payments for delivering targeted services to patients • CME • I.T. subsidy	Not Applicable	102 groups 1058 physicians 1,242,623 patients
Family Health Teams (FHT)	Apr-05	Interdisciplinary	• Regular and extended hours • Nurse-staffed THAS • Patient enrolment required	Three Options: • Blended capitation model (to groups with three or more physicians) • Blended complement model (to groups with one to seven physicians in specific defined areas of Ontario) • Blended Salary compensation model (available to community-led governance FHTs and mixed governance i.e., community and providers, FHTs)	Options: • Salary • Sessional funding • Contractual arrangement	150 teams operational by 2007/08

Primary Care Networks (PCN)	Introduced 1999 • Now Family Health Organization	Physician groups	• Regular and extended hours • Nurse-staffed THAS • Patient enrolment required	• Blended capitation model • Additional payments for delivering targeted care services	Not Applicable	12 PCN 170 physicians 299,626 patients
Health Service Organizations (HSO)	• Now Family Health Organization	Solo physicians or groups of physicians	• Regular and extended hours • Patient enrolment required • Nurse staffed THAS	• Blended capitation model • Additional payments for delivering targeted care services	Not Applicable	48 HSO 161 physicians 258,918 patients

Family Health Organization (FHO)	November-06	• Physician Groups • Harmonization of HSO and PCN models into one model • New groups in future • Three or more physicians	• Regular and extended hours • Nurse-staffed THAS • Patient enrolment required	• Blended capitation model • Additional payments for delivering targeted care services	Not Applicable	See PCNs and HSOs noted above. New groups in future
Rural & North Physician Group Agreement	April-04	• Physician Groups (Group 1 complement, 3-7; Group 2 complement, 1-2; New Group 3 complement, 1, 1.5, 2) to be added Spring 2007	• Regular and extended hours • Nurse-staffed THAS with access to Group physician if required • Patient enrolment incentives	• Base Remuneration • Incentives, premiums, special payments for delivering targeted care services • After-hours on-call services to patients	Not Applicable	14 RNPGA Group 1 25 RNPGA Group 2 Total for both groups: 39 groups 95 physicians 22,425 enrolled patients Expanding to 22 additional communities (14 of which will be Group 3) in Spring 2007

Community Health Centers (CHC) and Aboriginal Health Access Centers (AHAC)		• Interdisciplinary • Nonprofit organizations • Community governance • Integration with social services	• Regular and extended hours • Targets one or more priority groups/vulnerable populations	• Blended salary	Salary	54 CHC61 177 FTE physicians 10 satellite CHC 10 AHAC62 12.6 FTE physicians
Group Health Centre (GHC)	Opened in 1963 in Sault Ste. Marie; still in operation	• Interdisciplinary teams • Mixed governance	• Regular and extended hours • Nurse-staffed THAS	• Blended capitation • Additional payments for delivering targeted care services	Salary	36 primary care physicians, 19 specialist FTE and 11.07 FTE General Practice Specialists.60 61,000 patients
Shared Care Pilot Sites	2006	• Six pilot sites • Interdisciplinary teams with 3 to 15 physicians	• Regular and extended hours • Patient enrolment required • Nurse staffed THAS	• Fee-for-service • Additional payments for delivering targeted care services	Salary	Not Available

Appendix E

Key Components of The Chronic Care Model

Adapted from Barr et al., The Expanded Chronic Care Model: An Integration of Components and Strategies from Population Health Promotion and the Chronic Care Model [36]

COMPONENTS	
Health System	Program planning – measurable goals for better care of chronic illness
Self-Management Support	Focus on the importance of patients managing their own care
Decision Support	Evidence-based guidelines integrated into daily clinical practice
Delivery System Design	Multidisciplinary teams to support chronic care
Clinical Information Systems	Information systems to provide relevant data
Community Resources and Policies	Partnerships with community organizations to support patient needs

Appendix F

Key Components of The Expanded Chronic Care Model (British Columbia)

Adapted from Barr et al., The Expanded Chronic Care Model: An Integration of Components and Strategies from Population Health Promotion and the Chronic Care Model [36]

COMPONENTS	
Self-Management / Develop Personal Skills	Skills for personal health and wellness
Decision Support	Strategies for facilitating the capacity to maintain good health
Delivery System Design / Re-orient Health Services	Support for individuals and communities in a more holistic way
Information Systems	Information systems to collect data from the health care system and community in general
Healthy Public Policy	Development of policies to improve population health
Creative Supportive Environments	Provision of living and employment conditions that are safe, stimulating, satisfying and enjoyable
Strengthen Community Action	Partnership with community groups to help enhance the health of the community

Appendix G

Key Components of the Ottawa Charter of Health Promotion [136]

<table>
<tr><th colspan="2">COMPONENTS</th></tr>
<tr><td>Build Healthy Public Policy</td><td rowspan="6">Strategies for health promotion
Advocate good health
Enable equity in health
Mediate for coordinated action</td></tr>
<tr><td>Strengthen Community Action</td></tr>
<tr><td>Develop Personal Skills</td></tr>
<tr><td>Create Supportive Environments</td></tr>
<tr><td>Reorient Health Services</td></tr>
<tr><td>Moving into the Future</td></tr>
</table>

Appendix H

Classification of Diabetes [24]

Type 1 diabetes* encompasses diabetes that is primarily a result of pancreatic beta cell destruction and is prone to ketoacidosis. This form includes cases due to an autoimmune process and those for which the etiology of beta cell destruction is unknown.

Type 2 diabetes may range from predominant insulin resistance with relative insulin deficiency to a predominant secretory defect with insulin resistance.

Gestational diabetes mellitus refers to glucose intolerance with onset or first recognition during pregnancy.

Other specific types include a wide variety of relatively uncommon conditions, primarily specific genetically defined forms of diabetes or diabetes associated with other diseases or drug use.

*Includes latent autoimmune diabetes in adults (LADA), the term used to describe the small number of people with apparent type 2 diabetes who appear to have immune-mediated loss of pancreatic beta cells

Appendix I

DATE: May 30. 2011

LETTER OF INFORMATION / CONSENT FORM (*for physicians and nurse practitioners*)

Electronic Medical Records Interface Design Considerations for Improving Outcomes for Diabetes Management in Primary Care: A Usability Study

Purpose of the Study
Electronic Medical Records (EMRs) assist healthcare providers in delivering quality care to patients to help better manage chronic conditions, and in integrating services throughout the healthcare system so that relevant chronic disease programs can be made available to individuals and communities. In general, widespread adoption of EMRs within the primary care system in Canada has been slow, and among those who have adopted systems from various vendors, there have been complaints that application interface and design hinder the effective management of chronic disease in individuals and communities. Although there are many different factors affecting application usability – the ease with which an interface can be used – it is often overlooked as it is usually mistaken for user satisfaction, and is one of the least served areas in EMR design.

The objective of this study is to investigate the use of EMRs in managing diabetes and to evaluate their effectiveness in controlling the disease within primary care. With the kind cooperation of yourself and other primary care physicians (or nurse practitioner where necessary), this study will evaluate the usability of three different EMRs, with special reference to health care provider workflow, adherence to clinical practice guidelines and patient safety in managing individuals with diabetes.

The primary hypothesis is that EMRs provide promise in helping to control diabetes in patients. However EMR ease of use by health care providers can present significant hindrances in maximizing outcomes for disease management.

Other hypotheses include the effect of EMR usability on adoption rates, standardization of data entry, and the prevention and control of diabetes on the population level.

Since you are a *Primary Care physician / nurse practitioner* (will be adjusted as appropriate) I would very much appreciate your participation in this study. I am very interested in your opinions about your EMR use with regard to diabetes management.

Investigators:

Student Investigator:
Name: Urslin Fevrier-Thomas
Department: eHealth Program
McMaster University

Faculty Supervisor:
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Procedures involved in the Research
The study data will be collected via an anonymous online electronic questionnaire, which is expected to take you no more than 20 minutes to complete. The data will be analyzed using statistical tools, and the findings and literature review will be available later this year.

Potential Harms, Risks or Discomforts:
It is unlikely that your participation in this study will cause any harm, however some of the questions may cause you to reflect on past decisions which may be a source of discomfort.

Potential Benefits
I believe that the findings from this study will be helpful to Canadian physicians, the health care system in general, EMR vendors, and policy makers with regard to the use and functionality of EMRs in the management of chronic diseases for individuals and populations.

Payment or Reimbursement
You will not be paid to complete the questionnaire for this study, but your participation is greatly appreciated.

Confidentiality
Participation in this study is voluntary and all information collected will be stored securely and kept in strict confidence. Only the investigators named above will have access to the data. This is an anonymous questionnaire so there will be nothing linking you to the data or any reports and/or analyses resulting from this research project.

Participation and Withdrawal
This is a one-time questionnaire and your participation in this study is voluntary. You may terminate your participation in this questionnaire at any time by simply exiting the questionnaire.

Information about the Study Results
I expect to have this study completed by approximately August 2011. If you would like a brief summary of the results, please let me know how you would like it sent to you. Otherwise, the final report will appear as a working paper on the McMaster eBusiness Research Centre web site at http://merc.mcmaster.ca/.

Questions about the Study
If you have any concerns about the study, feel free to contact the researchers directly.

This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance. If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

McMaster Research Ethics Secretariat
Telephone: (905) 525-9140 ext. 23142
c/o Research Office for Administrative Development and Support

E-mail: ethicsoffice@mcmaster.ca

The questionnaire will take about 20 minutes to complete.

I have read the attached letter of information and agree to participate in this study. Continuing on to complete this questionnaire implies your agreement to participate in the study.
Please proceed to the questionnaire by clicking NEXT.

Appendix J

Questionnaire for Physicians

1. **Do you use an EMR to maintain clinical records for your patients?**
   a. ○ Yes (Please give the name of your EMR)
   _____
   b. ○ No

If you answered "Yes" to question # 1, please proceed with the questionnaire. If you answered "No" to question #1, thank you for your information. Please exit the questionnaire now.

2. **Your age range:**
   a. ○ 18 - 30
   b. ○ 31-50
   c. ○ Over 50

3. **Your gender:**
   a. ○ Male
   b. ○ Female

4. **Please indicate when your practice first began using an EMR (year)** _____

5. **Please check the following response that most closely represents your occupation:**
   a. ○ General Practitioner
   b. ○ Specialist
   c. ○ Other (please specify): _____

6. **How long have you been practicing medicine?**
   a. ○ 1-10 years
   b. ○ 11-20 years
   c. ○ 21-30 years
   d. ○ Over 30 years

7. **Considering all full and part-time clinicians at your main practice, including yourself, how many are**
   a. Physicians _____
   b. Nurse practitioners _____
   c. Mental Health Counsellors _____
   d. Dieticians _____
   e. Pharmacists _____
   f. Other (Please specify) _____

8. **On average, how many patient consultations do you personally have in your office every day?**
   a. ○ Less than 20
   b. ○ 21-30
   c. ○ 31-40
   d. ○ 41-50

e. ○ Over 50

9. About how many patients with diabetes do you see in a typical week?

a. ○ Less than 20
b. ○ 21-30
c. ○ 31-40
d. ○ 41-50
e. ○ Over 50

10. On average, how many minutes does a consultation with a patient with diabetes usually last?

a. ○ Less than 15 minutes
b. ○ Between 15 and 30 minutes
c. ○ Over 30 minutes
d. ○ Do not know

11. On average, how many minutes do you spend on data entry and documentation during and after each consultation?

a. ○ Less than 10 minutes
b. ○ Between 10 and 20 minutes
c. ○ Over 20 minutes
d. ○ Do not know

12. How often do you need to look up the correct diagnosis code when you are working in a patient chart?

a. ○ Never
b. ○ Sometimes
c. ○ Most of the time
d. ○ Always

13. Please indicate your agreement or disagreement with the following statements, considering your main office practice:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree
a. I am always looking for ways to experiment with/use new technologies							
b. I am able to complete tasks in the EMR without help from anyone							
c. I am always looking for ways to experiment with/use new features in the EMR							
d. In general we are always looking for ways that the EMR can help us improve quality of care							
e. We usually evaluate							

our systems and procedures for improving quality of care							

14. Using your EMR, how easy would it be for you or your staff to generate the following information about your diabetic patients?

	Do not know	Very Difficult	Difficult	Neutral	Easy	Very Easy
a. A count of patients by gender						
b. A list of patients by age group/category						
c. A list of patients diagnosed with diabetes						
d. A list of patients with BMI below or above a certain value						
e. A list of patients who are regular smokers and or alcohol drinkers						
f. A list of patients with BP consistently below or above a certain value						
g. A list of patients with diabetes who have not tested A1C within 3 months						
h. A list of patients with diabetes who have not tested their LDL within 3 months						
i. A list of patients with diabetes who have not had a foot exam in 6 months						
j. A list of patients with diabetes and their current medications						

15. The following questions deal with the use of Clinical Practice Guidelines (CPGs) in the management of diabetes. Please indicate your agreement with the following statements when managing patients with diabetes

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
a. The use of CPGs is important when managing diabetes in patients							
b. I always apply the relevant CPGs when managing patients with diabetes							
c. I use at least one of these functions (Reminders, Searches, CDMs, Flow-sheets, Stamps) in the EMR to help me adhere to CPGs for the management of patients with diabetes							
d. I use other applications							

aside from my EMR to help me manage my patients with diabetes							
e. In general, my patients with diabetes are better managed when I use functions in the EMR that help me adhere to CPGs (eg. Reminders to perform HbA1C tests within 3 months)							

16. Satisfaction with your EMR

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
a. I am confident that I will not lose my work if I make a mistake when using the EMR							
b. The reports /searches that I can generate from the EMR are exactly what I need							
c. I needed a lot of training before I felt confident using the EMR by myself							
d. The EMR is cumbersome to use							
e. The EMR has improved the quality of work in my practice							
f. The EMR fits in well with my workflow							
g. The EMR makes it easy for me to keep my patients' diabetes under control.							

17. EMR User interface

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
a. I can perform a task in more than one way in the EMR							
b. The EMR screens are clear and uncluttered							
c. I can usually complete a							

task in the EMR with very few steps							
d. The EMR allows me to use shortcuts to perform different tasks							
e. The action buttons in the EMR (eg. Ok, Cancel, etc) are appropriately placed							
f. The information the EMR provides is presented in a useful format							

18. Application Design

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
a. The EMR allows for different user roles in my practice							
b. I can change certain default settings in the EMR like font size, colors, and views to suit my needs							
c. I can customize certain default forms, templates and reports in the EMR to suit my needs							
d. If I cannot change a setting in the EMR myself, I can get it easily done by the vendor or other support person							
e. The EMR provides helpful information to help me use it better							
f. I have to enter the same information in more than one place in the EMR							

19. Decision Support

a. The EMR provides clear warnings about drug interactions and allergies while I am working in a patient chart							
a. The EMR presents							

alerts only when it is appropriate							
b. The EMR provides choice lists that are clear and unambiguous							
c. The EMR provides a comprehensive list of diagnoses for me to choose from							
d. The EMR is able to calculate BMI based on the current weight and height available in the patient chart							
e. There are so many diagnoses in the EMR that it is sometimes difficult for me to know which to select							

Case Scenario:

Consultation with patient with chronic Type 2 Diabetes

An obese patient with consistent elevated LDL, chronic hypertension and type 2 diabetes goes to his primary care physician for a consultation. In addition to the patient's vital signs and weight, the doctor requires a fasting blood sugar reading in the office, and a lipid panel and HbA1c - both of which have to be performed at a local lab. The patient was previously given instructions to go to a local lab to get the lipid panel and HbA1c done, and also to fast for 8-12 hours before the appointment time. Additionally, a diabetic foot exam and intervening history will be performed in the office by the nurse before the doctor sees the patient.

.

The following tasks have been broken down into activities that may be performed during care management of a patient:

1. Review patient history and pre-consultation activities performed by the nurse (fasting blood sugar, vital signs, weight, perform diabetic foot exam, get intervening history and send out lab orders for lipid panel and HbA1c)
2. Consultation with the patient
3. Review care management and develop treatment plan
4. Change existing prescription based on consultation and lab results: increase dosage of current medication
5. Provide relevant information to patient

20. For each activity, please select the appropriate response based on the management of a patient with diabetes in your practice and the use of your EMR:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree

Evaluate Task 1: Review patient history and pre-consultation activities

a. Lab tests and procedures that were performed are clearly identified in the EMR							
b. I am able to get a quick snapshot of the patient's health status from the EMR							
c. I am able to quickly see specific occurrences of events in the patient's medical history from the EMR							
d. I am able to easily add any new or additional flowsheets and/or stamps to the patient record based on their condition							
e. I am able to obtain patient information from hospital reports directly through the EMR (eg. use of EMR Download)							
f. If the notes were organized by diagnosis or problem (instead of chronologically), it would be easier to find what I am looking for							

Evaluate Task 2: Consultation with patient

a. I update information in the patient chart as I consult with the patient							
b. The EMR allows me to follow a standard format in consultation when I am with a patient with diabetes							
c. Sometimes it is easier to ask the patient than to look for the information in the EMR							
d. I use diagnosis codes in the EMR to track my patients' conditions (eg. ICD9, SNOMED)							
e. Using the EMR during the consultation helps to provide a more efficient patient encounter							
f. It is cumbersome to get information from the EMR that can help me manage patients with diabetes							

Evaluate Task 3: Review care management plan and develop treatment plan

a. The EMR provides helpful information to help me make decisions about:							
i. Target LDL							
ii. Aspirin therapy indication							
iii. Periodic testing							
iv. Immunizations							
v. Treatment plan based on various risk factors							
b. Referrals to other providers							
The EMR offers the ability to provide direct referrals to other providers in my practice							
The EMR offers the ability to provide secure clinical messaging between providers in my practice							

Evaluate Task 4: Change existing prescription based on diagnosis

a. I am able to adjust the existing prescription dosage using the EMR							
b. I am able to change the existing medications using the EMR							
c. I sometimes find it difficult to manage medications in the EMR							
d. The EMR provides a comprehensive list of medications to choose from							
e. The EMR provides suggestions for alternatives when drug-drug or adverse drug interactions occur							
f. I can transmit prescriptions to the pharmacy directly through the EMR							

Evaluate Task 5: Providing information to patients

a. Using the EMR, I can show patients their historical progress with their condition							
b. I can print out the relevant handouts in the EMR for my patients to help them manage their diabetes							

c. I can use email within the EMR to electronically send the relevant handouts to my patients to help them manage their diabetes							
d. The EMR offers the ability for me to provide my patients with sick							
e. I use the patient portal in my EMR to exchange information with my patients to help them manage their diabetes better							

21. Comments 1: Please provide any additional information regarding your use of the EMR in managing diabetes.

22. Comments 2: Please provide any additional information regarding your satisfaction with your EMR.

Appendix K

Questionnaire for Nurses

6. Do you use an EMR to maintain clinical records for your patients?

a. ○ Yes (Please give the name of your EMR) _____
b. ○ No

If you answered "Yes" to question # 1, please proceed with the questionnaire.
If you answered "No" to question #1, thank you for your information. Please exit the questionnaire now.

7. Your age range:

a. ○ 18 - 30
b. ○ 31-50
c. ○ Over 50

8. Your gender:

a. ○ Male
b. ○ Female

9. What is your occupation? _____

10. How long have you been in your present occupation?

a. ○ 1-10 years
b. ○ 11-20 years
c. ○ 21-30 years
d. ○ Over 30 years

11. Considering all full and part-time clinicians at your main practice, including yourself, how many are

a. Physicians _____
b. Nurse practitioners _____
c. Mental Health Counsellors _____
d. Dieticians _____
e. Pharmacists _____
f. Other (Please specify) _____

12. Of all the full and part-time clinicians at your main practice, which of them makes updates to the patients' charts within the EMR? (check all that apply)

g. ○ Physicians
h. ○ Nurse practitioners
i. ○ Mental Health Counsellors
j. ○ Dieticians
k. ○ Pharmacists
l. ○ Other (Please specify) _____

13. **On average, how many patient consultations do YOU manage in your office every day?**
    a. ○ Less than 20
    b. ○ 21-30
    c. ○ 31-40
    d. ○ 41-50
    e. ○ Over 50

14. **About how many patients with diabetes do YOU see in a typical week?**
    a. ○ Less than 20
    b. ○ 21-30
    c. ○ 31-40
    d. ○ 41-50
    e. ○ Over 50

15. **On average, how many minutes does YOUR consultation with a patient with diabetes usually last?**
    a. ○ Less than 15 minutes
    b. ○ Between 15 and 30 minutes
    c. ○ Over 30 minutes
    d. ○ Do not know

16. **On average, how many minutes do YOU spend on data entry and documentation during and after each consultation?**
    a. ○ Less than 10 minutes
    b. ○ Between 10 and 20 minutes
    c. ○ Over 20 minutes
    d. ○ Do not know

Case Scenario:

Consultation with patient with chronic Type 2 Diabetes

An obese patient with consistent elevated LDL, chronic hypertension and type 2 diabetes goes to his primary care physician for a consultation. In addition to the patient's vital signs and weight, the doctor requires a fasting blood sugar reading in the office, and a lipid panel and HbA1c - both of which have to be performed at a local lab. The patient was previously given instructions to go to a local lab to get the lipid panel and HbA1c done, and also to fast for 8-12 hours before the appointment time. Additionally, a diabetic foot exam and intervening history will be performed in the office by the nurse before the doctor sees the patient.

.

The following tasks have been broken down into activities that may be performed during care management of a patient:

1. Make appointment for patient
2. Send blood screening order to local lab
3. Initial review of patient medical record
4. Nurse performs pre-consultation activities - obtain fasting blood sugar, vital signs, weight, perform diabetic foot exam, get intervening history and send out lab orders for lipid panel and HbA1c
5. Nurse consults with the patient
6. Nurse updates the patient record in the EMR

For each activity, please select the appropriate response based on the management of a patient with diabetes and the use of your EMR:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
17. Evaluate Task 1: Make appointment for patient							
a. It is easy for the office staff to schedule an appointment for patients using the EMR							
18. Evaluate Task 2: Send blood screen order to local lab							
a. We keep a set of hard copy paper forms that we use for orders to local labs							
b. We use a set of custom forms in the EMR for local lab orders							
c. The custom forms we use in the EMR already have the patient's information on it when we want to use it							
d. The custom forms we use in the EMR already have our office information on it when we want to use it							
e. We are able to send lab orders to local labs directly through the EMR							
f. We are able to send imaging/radiology orders directly through the EMR							
g. We have to print out the lab orders from the EMR and then fax them to the local lab							
h. We have to hand write patient or office information on the lab orders before faxing them to the local lab							
19. Evaluate Task 3: Review patient record							
a. I am able to quickly see the patient's age and gender in the EMR							
b. I am able to get a quick snapshot of the patient's health status from the EMR							
c. We are able to get test results directly into the EMR from test providers							
d. Lab tests and procedures that were performed are clearly identified in the EMR							
20. Evaluate Task 4: Preparations prior to doctor seeing patient							

a. The EMR allows me to follow a standard format when updating information for patients with diabetes							
b. It is easy for me to follow any pre-consultation instructions from the doctor regarding patients with diabetes from the EMR							
c. The instructions in the EMR are clear and unambiguous							

21. Evaluate Task 5: Updating the patient record in the EMR

a. It is easy for me to update the patient record in the EMR with the information obtained from any pre-consultation activities							
b. When I update the patient record, I am able to type the values obtained in pre-defined or pre-labelled spaces							
c. There are no pre-defined or pre-labelled spaces in the EMR and I have to type everything for each patient							
d. The EMR is able to calculate BMI based on the current weight and height available in the patient chart							
e. I have to manually calculate the patient's BMI and input it in the patient's chart							

22. Evaluate Task 6: Consultation with patient

a. I spend too much time looking for information in the EMR during the consultation with the patient							
b. I spend too much time updating the EMR during the consultation with the patient							
c. I do not update any information in the patient chart during the consultation with the patient							
d. The EMR distracts me during the consultation with the patient							
e. We use billing codes in the EMR based on diagnoses							

and treatments for our patients							
f. I can print out the relevant handouts in the EMR for patients to help them manage their diabetes							

23. Satisfaction with the EMR

a. Using the EMR during the consultation helps to provide a more efficient patient encounter							
b. The EMR makes it easy for us to keep our patients' diabetes under control							
c. Using the EMR during the consultation makes the patient encounter less effective							
d. We use other applications aside from the EMR to help us manage patients with diabetes							
e. Our population of patients with diabetes are better managed using the EMR							

24. Comments 1: Please provide any additional information regarding your use of the EMR in managing diabetes.

25. Comments 2: Please provide any additional information regarding your satisfaction with your EMR.

Appendix L

DATE: July 13, 2011

LETTER OF INFORMATION / CONSENT FORM *(for Dietitians)*

Electronic Medical Records Interface Design Considerations for Improving Outcomes for Diabetes Management in Primary Care: A Usability Study

Purpose of the Study
Electronic Medical Records (EMRs) assist healthcare providers in delivering quality care to patients to help better manage chronic conditions, and in integrating services throughout the healthcare system so that relevant chronic disease programs can be made available to individuals and communities. In general, widespread adoption of EMRs within the primary care system in Canada has been slow, and among those who have adopted systems from various vendors, there have been complaints that application interface and design hinder the effective management of chronic disease in individuals and communities. Although there are many different factors affecting application usability – the ease with which an interface can be used – it is often overlooked as it is usually mistaken for user satisfaction, and is one of the least served areas in EMR design.

The objective of this study is to investigate the use of EMRs in managing diabetes and to evaluate their effectiveness in controlling the disease within primary care. With the kind cooperation of yourself and other primary care clinicians, this study will evaluate the usability of three different EMRs, with special reference to health care provider workflow, adherence to clinical practice guidelines and patient safety in managing individuals with diabetes.

The primary hypothesis is that EMRs provide promise in helping to control diabetes in patients. However EMR ease of use by health care providers can present significant hindrances in maximizing outcomes for disease management.

Other hypotheses include the effect of EMR usability on adoption rates, standardization of data entry, and the prevention and control of diabetes on the population level.

Since you are a Primary Care clinician I would very much appreciate your participation in this study. I am very interested in your opinions about your EMR use with regard to diabetes management.

Investigators:

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Procedures involved in the Research
The study data will be collected via an anonymous online electronic questionnaire, as well as face-to-face interviews. The data will be analyzed using statistical tools, and the findings and literature review will be available later this year.

Potential Harms, Risks or Discomforts:
It is unlikely that your participation in this study will cause any harm, however some of the questions may cause you to reflect on past decisions which may be a source of discomfort.

Potential Benefits
I believe that the findings from this study will be helpful to Canadian physicians, the health care system in general, EMR vendors, and policy makers with regard to the use and functionality of EMRs in the management of chronic diseases for individuals and populations.

Payment or Reimbursement
You will not be paid to complete the questionnaire for this study, but your participation is greatly appreciated.

Confidentiality
Participation in this study is voluntary and all information collected will be stored securely and kept in strict confidence. Only the investigators named above will have access to the data. There will be nothing linking you to the data or any reports and/or analyses resulting from this research project.

Participation and Withdrawal
Your participation in this study is voluntary. You may terminate your participation in this interview at any time.

Information about the Study Results
I expect to have this study completed by approximately August 2011. If you would like a brief summary of the results, please let me know how you would like it sent to you. Otherwise, the final report will appear as a working paper on the McMaster eBusiness Research Centre web site at http://merc.mcmaster.ca/.

I have read the preceding information thoroughly. I have had an opportunity to ask questions and all of my questions have been answered to my satisfaction. I agree to participate in this study.

Name	Signature	Date

Person obtaining consent:
I have discussed this study in detail with the participant. I believe the participant understands what is involved in this study.

Name, Role in Study	Signature	Date

Appendix M

Face-to-Face Interview with Dietitians

26. Do you use an EMR to maintain clinical records for your patients?

c. ◯ Yes (Please give the name of your EMR) _____

d. ◯ No

If you answered "Yes" to question # 1, please proceed with the questionnaire.
If you answered "No" to question #1, thank you for your information. Please exit the questionnaire now.

27. Your age range:

d. ◯ 18 - 30
e. ◯ 31-50
f. ◯ Over 50

28. Your gender:

c. ◯ Male
d. ◯ Female

29. What is your occupation? _____

30. How long have you been in your present occupation?

e. ◯ 1-10 years
f. ◯ 11-20 years
g. ◯ 21-30 years
h. ◯ Over 30 years

31. Considering all full and part-time clinicians at your main practice, including yourself, how many are

m. Physicians _____
n. Nurse practitioners _____
o. Mental Health Counsellors _____
p. Dieticians _____
q. Pharmacists _____
r. Other (Please specify) _____

32. Of all the full and part-time clinicians at your main practice, which of them makes updates to the patients' charts within the EMR? (check all that apply)

s. ◯ Physicians
t. ◯ Nurse practitioners
u. ◯ Mental Health Counsellors
v. ◯ Dieticians
w. ◯ Pharmacists
x. ◯ Other (Please specify) _____

33. On average, how many patient consultations do YOU manage in your office every day?

a. ◯ Less than 20
b. ◯ 21-30
c. ◯ 31-40
d. ◯ 41-50
e. ◯ Over 50

34. About how many patients with diabetes do YOU see in a typical week?

a. ◯ Less than 20
b. ◯ 21-30
c. ◯ 31-40
d. ◯ 41-50
e. ◯ Over 50

35. On average, how many minutes does YOUR consultation with a patient with diabetes usually last?

a. ◯ Less than 15 minutes
b. ◯ Between 15 and 30 minutes
c. ◯ Over 30 minutes
d. ◯ Do not know

36. On average, how many minutes do YOU spend on data entry and documentation during and after each consultation?

a. ◯ Less than 10 minutes
b. ◯ Between 10 and 20 minutes
c. ◯ Over 20 minutes
d. ◯ Do not know

Case Scenario:

Consultation with patient with chronic Type 2 Diabetes

An obese patient with consistent elevated LDL, chronic hypertension and type 2 diabetes is referred to you for a consultation after having been to his primary care physician. Latest values for the patient's vital signs, weight, fasting blood sugar, lipid panel and HbA1c have been recorded in the EMR. Additionally, a diabetic foot exam was performed in his physician's office at his last visit.

Please describe the following:

37. How do you get the information regarding the referral for the patient
38. What kind of information about the patient is provided to you
39. How is clinical information about the patient made available to you
40. How is an appointment made for you to consult with a patient
41. How do you manage patients with diabetes – making specific reference to your use of the EMR (if any) to assist you in this process.

For each activity, please select the appropriate response based on the management of a patient with diabetes and the use of your EMR:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
42. Review patient record							
e. I am able to quickly see the patient's age and gender in the EMR							
f. I am able to get a quick snapshot of the patient's health status from the EMR							
g. I am able to see relevant test results for patients in the EMR							
h. Lab tests and procedures that were performed are clearly identified in the EMR							
43. Updating the EMR							
d. The EMR allows me to follow a standard format when updating information for patients with diabetes							
f. It is easy for me to update the patient record in the EMR with the information obtained during my consultation with him/her							
44. Consultation with patient							
g. I spend too much time looking for information in the EMR during the consultation with the patient							
h. I spend too much time updating the EMR during the consultation with the patient							
i. The EMR distracts me during the consultation with the patient							
j. I can print out the relevant handouts in the EMR for patients to help them manage their diabetes							
45. Care and Treatment Plans							
a. The EMR provides useful information to help me make decisions regarding diabetes patients treatment plans							
b. The EMR is useful in providing coordination of care for diabetes patients							
46. Satisfaction with the EMR							
f. Using the EMR during the consultation helps to provide a more efficient patient encounter							
g. The EMR makes it easy for me to help my patients keep their diabetes under control							
h. I use other applications aside from the EMR to help me manage patients with diabetes							

i. My population of patients with diabetes is better managed using the EMR							

47. Comments 1: Please provide any additional information regarding your use of the EMR in managing diabetes.

48. Comments 2: Please provide any additional information regarding your satisfaction with your EMR.