

A synthesis of the current evidence base in home-based chronic care telehealth and identification of priority research questions

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About the BCATPR

The British Columbia Alliance on Telehealth Policy and Research (BCATPR) is a multi-disciplinary health services research team that started out with an initial four-year grant from the Michael Smith Foundation for Health Research through the Health Services and Policy Research Support Network in 2005. It has since received funding from the Vancouver Foundation, the Heart and Stroke Foundation of BC & Yukon, the Canadian Institutes of Health Research, Vancouver Coastal Health, Provincial Health Services Authority, Northern Health Authority, Providence Health Care, and Pfizer Canada Inc. for its projects.

The BCATPR is a joint partnership consisting of academic institutions and provincial health authorities committed to provide relevant evidence and capacity building for integration of sustainable telehealth care services into routine health care practices within British Columbia. The BCATPR addresses key questions within three established research themes of particular importance to health authorities:

The Patient: Self-Managed Care, Technology Uptake and Behaviour

This theme addresses the use of Internet-support technology to deliver self-managed care to patients with cardiovascular disease directly into their homes to improve patient care and outcomes. The majority of management strategies for cardiovascular disease depend primarily on patient self-management, uptake and behaviour change with other factors such as blood pressure and blood glucose monitoring requiring active interaction with the patient care providers.

The Provider: Integration of Clinical Care

This theme addresses the use of telehealth to integrate clinical care to facilitate shared care between primary and secondary care providers. As a complex chronic disease, the management of cardiovascular disease involves physicians, nurses, allied health professionals and multiple health services. Clinical integration can be defined as the sharing of care between different levels of providers to improve health outcomes and create system sustainability.

Policy: Telehealth Policy and Health Human Resources

This theme addresses the implications of telehealth services on health care policy and vice-versa, and the impact of these services and policy on health human resources. The fundamental nature of telehealth is borderless electronic networking with the capability to transcend geo-political, socio-cultural and temporal boundaries. For telehealth to function effectively, a clear and supportive policy environment is required that facilitates and manages inter-jurisdictional telehealth and integrates it with existing health policy.

Institutional Partners

Simon Fraser University

University of British Columbia

University of Northern British Columbia

Fraser Health Authority

Interior Health Authority

Northern Health Authority

Provincial Health Services Authority

Vancouver Coastal Health Authority

Vancouver Island Health Authority

Executive Summary

Telehealth has been increasingly utilized in Canada to improve patient access to health services despite geographical, cultural and socio-economical barriers and has the potential to prevent hospitalization, reduce health care costs and provide an alternative to conventional hospital outpatient or health professional visits. The primary purpose of this descriptive report is to provide a representative picture of home-based chronic care telehealth, and to identify key gaps and priority research questions pertaining to: the patient, the provider and policy.

Patient Theme

- Despite the growing availability of telehealth technology infrastructure, telehealth utilization in Canada remains limited in many home and community settings, and within Canadian primary care settings.
- While data on actual uptake is limited, patients' attitudes to home-based telehealth services are frequently discussed, providing insight into patient willingness to use home-based telehealth applications.
- The evidence presented suggests that home-based telehealth applications can positively affect self-management for patients with chronic disease.
- The most effective home-based telehealth applications to date are monitoring of vital signs and telephone follow-up by nurses for patients with chronic diseases.
- Canadian organizations providing telehealth services to patients – including those in the home setting rarely perform comprehensive evaluations of telehealth applications. Indeed, only 46% of organizations either actively collected or were developing a collection process for clinical outcomes and cost-analysis data.

Provider Theme

- Home-telehealth systems appear to enhance provider-patient communication and provide closer health monitoring compared to face-to-face consultations. Physicians reported that information derived from home-based telehealth applications is helpful in assisting with patient monitoring and assessing patient stability.
- Information on provider uptake of telemonitoring technologies is rare. Most studies focus on clinical and behavioural outcomes/changes, and not on provider perceptions or uptake.

Policy Theme

While the data are sparse in terms of detailing specific policies on home-based telehealth, the literature tends to focus on national or provincial level telehealth policies for service delivery in clinics and hospitals. Above all, critiques of current telehealth care policy – or the lack thereof – dominate the literature.

Although the literature on telehealth is constantly growing, this scoping review demonstrates that the research on home-based telehealth applications is far from comprehensive, particularly in the Canadian context. Nevertheless, the priority research questions conceived from the gaps identified in this review are expected to stimulate further avenues for research on home-based telehealth applications to help inform policy-makers and health care providers in telehealth implementation.

Introduction

According to the Provincial Health Services Authority (PHSA) of British Columbia (BC), telehealth can be defined as the use of Information and Communications Technologies (ICTs) to deliver health and health care services, information and education at a distance (PHSA, 2008). Telehealth has been increasingly utilized in Canada to improve patient access to health services despite geographical, cultural and socio-economical barriers. Telehealth can be applied to a variety of settings, including hospitals, clinics, ambulances and prisons, but the most prevalent and promising location for telehealth is in the patient's home (Meystre, 2005). Indeed, provision of care directly to the patient's home has the potential to prevent hospitalization, reduce health care costs and provide an alternative to conventional hospital outpatient or health professional visits.

Although telehealth services at large have been employed in various capacities for several years, home-based telehealth applications are still relatively new to the healthcare system (Koch, 2005). Yet, as the burden of chronic illnesses on the Canadian healthcare system grows and the scarcity of health human resources in rural and remote regions intensifies, home-based telehealth applications have increasingly been identified as a possible mitigating factor, as well as a potentially effective way to treat and rehabilitate patients with chronic diseases (Hebert, Korabek, & Scott, 2006; Schaafsma et al., 2007; Liddy et al., 2008; Pare, Jaana, & Sicotte, 2007). Examples of home-based telehealth applications include: consultations between health professionals and patients; lifestyle management and behavioural change support; and patient vital signs monitoring (Dellifrairie & Dansky, 2008; Koch, 2005). These services are provided through various technologies including the Internet, telephone, videophone, videoconferencing units, and other types of monitoring systems (Koch, 2005; Barlow et al., 2007; Dellifrairie & Dansky, 2008). The present scoping review provides a representative picture of homebased chronic care telehealth, identifying key gaps and priority research questions pertaining to BCATPR's three priority themes.

Methodology

A scoping review is typically undertaken to locate existing systematic reviews and major randomized clinic trials to provide further focus for the direction of proposed research questions (UBC Health Library Wiki, 2008). Scoping searches draw on major databases, and involve a refining process to identify which information sources should be searched more thoroughly. The scoping process is iterative and helps to estimate the breadth and depth of the literature in question. Therefore, the present scoping review is a preliminary attempt to provide an overview of the existing literature on home-based chronic care telehealth, and identify where further research may be required.

With the support of BCATPR members, a scoping search strategy was developed by the research team. This search strategy was discussed with a University of British Columbia biomedical librarian to ensure its effectiveness in yielding all relevant articles. Published peer-reviewed literature pertaining to home-based chronic care telehealth was identified via a systematic search of the following databases: Medline, EMBASE, CINAHL, and Web of Science. The Journal of Telemedicine and Telecare was hand searched due to its particular relevance to this scoping review. In addition, grey literature was surveyed and found through Google Scholar and the websites of the Provincial Health Services Authority, the Canadian Society of Telehealth, and Canada Health Infoway. All articles and reports were restricted to include only those written in the English language and published between the years of 2003 and 2008. The restriction on publication dates was instituted due to this scoping review's focus on recent trends and occurrences in the field of home-based telehealth. There were no restrictions on the type of telehealth technology used (to view the complete search strategy, please see Appendix A). The initial search yielded 583 peer-reviewed articles from the databases, 36 peer-reviewed articles from the Journal of Telemedicine and Telecare and 7 articles and reports from the grey literature. In total, 626 sources were found using the initial search criteria.

Following the structure of a scoping review strategy, the initial search results were further restricted to peer-reviewed and grey literature that met one of the following inclusion criteria: 1) meta-analyses; 2) review articles; 3) randomized control trials; 4) Canadian articles or reports; and 5) articles of direct relevance to Canadian home-based telehealth that nonetheless did not fit the previous four search parameters (ie. grey literature)¹. After titles and abstracts were scanned for relevance, 51 articles or reports were included.

Results

This scoping review is focused on home-based telehealth, but with the majority of research activity focused on telehealth at large, certain articles or reports on non-homebased telehealth have been included when relevant. In particular, home-based telehealth trends and home-based telehealth policy are both strongly impacted by larger occurrences and shifts in the field of general telehealth. As a result, sections (i) and (iv) include articles or reports on telehealth more generally. On the other hand, both the Patient and Provider sub-sections are almost singularly focused on home-based telehealth due to the differences between home-based and non-home-based telehealth in terms of services offered, outcomes, etc.

To this end, the four main components of the Results section are:

i) Home-Based Telehealth Trends

¹ Articles may have bridged multiple categories. For a complete annotated bibliography of all included articles, please see the *Evidence Companion*.

- ii) Patient
- iii) Provider
- iv) Policy

i) Home-Based Telehealth Trends

a) An International Perspective

Although telehealth is a well-understood concept, there is no single or homogenous definition. In fact, as many as 104 peer-reviewed definitions of telemedicine have been found in the literature (Sood, 2007). Exclusively in the homebased telehealth context, there is a great deal of variance in the literature. Studies on diabetes and heart disease are consistently found to be the primary focus in this area (Koch, 2005; DelliFrane & Dansky, 2008; Pare, 2007; Janna & Sicotte, 2007; Barlow et al., 2007; Vasquez, 2008; Dorr et al., 2006). Table 1 presents a breakdown of home telehealth literature by type of chronic disease. Chronic diseases that are rarely discussed in the literature include: anxiety, cancer, neurological conditions, cerebrovascular disease, various psychological disorders, and other less prevalent heart diseases (Liddy et al., 2008). The heavy emphasis on particular chronic diseases is not entirely unwarranted. Patients suffering from heart failure and diabetes are at a high risk for re-hospitalization, indicating that these patients place a significant burden on the health care system (Vasquez, 2008). Despite the similar burden that chronic obstructive pulmonary disease (COPD) and cancer patients place on the health care system, these patient populations are under-represented in the literature, and as such, it is not well known whether or not these diseases are conducive to home-based telehealth applications.

Chronic Disease / Patient Focus	Prevalence in Literature
Diabetes	31%
Heart Disease	29%
Multiple Chronic Diseases	10%
Depression	9%
Elderly	7%
Hypertension	5%
Asthma	3%
Chronic Obstructive Pulmonary Disease	3%
Chronic Back Pain	1%
Dementia	1%
Arthritis	1%

Source: Adapted from Barlow et al. (2007)

There are also significant differences in the types of services utilized in home telehealth studies. Home telehealth technologies comprise a large spectrum, but generally fit into one of three categories (Hebert, Korabek & Scott, 2006; DelliFrane & Dansky, 2008; Koch, 2005):

1) Patient-initiated contact

- Tele-triage call centres (patient initiates call based on perceived symptoms)

- Chronic care vital signs monitoring (patient initiates call to report vital signs)
- Web-based clinical consultations (patient initiates request for consultation)

2) Auto-monitoring

- Telephone surveillance (an automated recording calls to follow-up on initial diagnosis or consultation)
- Medication compliance (an automated recording calls to remind patients of their medication prescriptions)
- Data monitoring (automated transfer of patient vital signs to health professionals)²
- Medical device monitoring (remote monitoring of medical devices to ensure proper functioning and use)

3) Healthcare professional-initiated contact

- Videophone consultation (a nurse initiates call based on a pre-arranged visit schedule)
- Surveillance-disease management (a health professional initiates call to check on patient and ensure proper disease management, and provide decision support and patient education materials)
- Store-and-forward systems (a primary physician transmits images and other data to a specialist for review)

The majority of home-based chronic care telehealth literature focuses slightly more on males (although not to a significant effect), and on adults (21-65 years old) or the elderly (65 years and over) (DelliFraine and Dansky, 2008; Liddy et al., 2008). The race or ethnicity of participants generally remains unidentified, but several articles specifically address Aboriginal groups. Although the quality of home-based telehealth evaluations in particular is unknown, the methodological limitations of general telehealth evaluations can provide some insight into the general lack of sound evaluations in this area. For example a systematic review of 79 studies examining the impact of telehealth on patient and provider satisfaction found that most telehealth studies are based on sample sizes of less than 100, and only 11% of patient studies, and 4% of provider studies, use randomized selection of participants (Whitten et al., 2007). In another systematic review of 46 articles, only 52% of studies that included a control group in their methodology were found to have good to excellent reliability of findings (Hailey, Ohinmaa & Roine, 2004).

Compared to other nations, Canada lags behind in publications on telehealth. This is despite the establishment of home-based telehealth as a national priority (Koch, 2007). Although the number of home-based telehealth publications has noticeably increased over the years both within and outside of Canada (from 1 in 1990 to 101 in 2003 across 13 countries), Canada's rank in article output remains marginal, on par with other mid-ranked countries such as Australia, France and Spain (Koch, 2007). Only Sweden and Finland have significantly lower publication outputs than Canada. The United States tops the number of publications, followed by the United Kingdom (U.K.) (Koch, 2005; Pare et al., 2007). With the exception of the U.S., these publication numbers are reflective of implemented telehealth applications around the world. The U.K., New Zealand and Australia have a proportionately higher prevalence of electronic medical records, electronic prescribing, and electronic management of chronic disease than the U.S. and Canada, but it is unclear whether other home-based telehealth applications conform to this trend (Anderson, 2006). Nonetheless, Canada is an active partner in the International Organization for Standardization's Technical Committee on Health Informatics, a committee dedicated to developing national and international standards for telehealth and other e-health initiatives.

b) A National Perspective

Canada has a demonstrated interest in developing telehealth initiatives and programs. In 2001, the National for Telehealth Guidelines (NIFTE) developed a Canadian framework for health professionals, telehealth provider orga-

² Data monitoring and audio-video consultations are found to be the most prevalent home-based telehealth application studied in the literature, respectively.

nizations, and accrediting agencies to develop accreditation standards in telehealth (Hogenbirk, et al., 2006). Through NIFTE, the following projects were initiated: convening a network of stakeholders to assist Canadian telehealth development; creating a database of telehealth stakeholders, programs, providers and technology developers; completing an environmental scan of the current status of Canadian telehealth; developing guidelines for telehealth standards; provision of telehealth information to the Canadian Council for Health Service Accreditation; and the dissemination of initiative information. The NIFTE initiative is one of many examples across Canada (e.g. Canadian Institute of Health Information, Canada Health Infoway, the Newfoundland and Labrador Centre for Health Information, Alberta Wellnet, BC Peace Liard Telemental Health, Ontario Telemedicine Network, etc.) that have been implemented to facilitate the growth of Canadian telehealth and other e-health applications (Alvarez, 2002). Another achievement that exemplifies Canada's long-term interest in telehealth research and the growth of telehealth infrastructure in Canada is that the first issue of the tenth anniversary volume of the journal *Telemedicine and e-Health* was dedicated to the Canadian telehealth community (Cloutier, 2004).

Despite the growing availability of telehealth technology infrastructure, telehealth utilization in Canada remains limited in many home and community settings (Gagnon, 2007). Home care services for patients have the potential to shorten and decrease hospital stays and provide more cost-effective outpatient procedures compared to traditional institutional care (Canadian Home Care Association, 2008). The benefits of home-based telehealth applications combined with the hundreds of geographically isolated communities spread out across ten million square kilometers - some in extreme climate environments - have made the provision of equitable, accessible and high quality home-based healthcare a high priority in Canada (Alvarez, 2002). The process of implementing accessible home-based care is further prioritized due to the disproportionately lower rates of social and community health for Aboriginal people compared to the general Canadian population (Department of Indian and Northern Affairs Canada, 1996). This disproportion can be attributed to the geographic isolation, inadequate environmental conditions and housing, and inconsistent access/delivery of health services to many rural and remote communities (Ho & Jarvis-Selinger, 2006).

An estimated one million patients receive home care annually across Canada, and even higher numbers of transactions associated with home care are reported (e.g. home visits, calls to health care providers, and equipment ordering) (CHCA, 2008). However, it is unknown what portion of Canadian home care is enabled via telehealth (CHCA, 2008). Pilot home-based telehealth projects across the country have identified best practices (i.e. leadership, project management, and change management), but the full potential of home-telehealth services in the Canadian healthcare system has yet to be realized. Home care leaders across Canada have identified limitations in information technologies as a barrier to the health care sector's ability to evaluate, compare, and plan for the future needs and services of home-telehealth in Canada (CHCA, 2008). Nevertheless, Canada's health care system is beginning to prioritize the transition of telehealth to home settings in order to provide services to Canada's aging population and those living in rural, remote and isolated communities with chronic diseases (CHCA, 2008).

ii) Patients

a) Uptake & Use of Technology

Despite the reported benefits of home-based telehealth applications, they have not been widely implemented in Canadian primary care settings. Some pilot studies have, however, been implemented and subsequently published. For example, Liddy et al. (2008) implemented a home-based telehealth application program in Ottawa over a 16-month period, for patients with one or more chronic illnesses. Patient, caregiver, and healthcare provider satisfaction were

Initiative recorded. General satisfaction was found to be overwhelmingly positive, and the telehealth applications were perceived to be userfriendly and reliable. Another example of a home telehealth initiative was implemented in New Brunswick. This project combined an interdisciplinary staff intervention (physicians, specialists and administrators), store-and-forward technologies and a patient education program to improve clinical outcomes for patients with chronic disease (CHCA, 2008). While these examples provide some evidence to support home-based telehealth applications, detailed descriptions of home-based telehealth uptake across locations, diseases, and/or patient groups is lacking.

Although accounts of patients' actual uptake and use of telehealth services are sparse in the literature, the impact of home-based telehealth applications on patients attitudinal effects are frequently discussed, providing insight into patient willingness to use home-based telehealth applications. Although patient attitudes and satisfaction are discussed more so than effects on clinical outcomes, data quality, clinical effectiveness or economic viability, clinical outcomes have since emerged as an important area of focus in the home-based telehealth literature (Ho & Jarvis Selinger, 2006; Pare, Jenna & Sicotte, 2007; Barlow et al., 2007; Pare et al., 2007). While a small number of patients find home-based telehealth applications awkward, confusing or a nuisance, the majority of patients are receptive and exhibit a positive attitude towards telehealth as a patient management approach (Liddy et al., 2008). This is particularly true for pulmonary conditions and diabetes, where patients have high levels of acceptance and satisfaction (Pare et al., 2007). Other reported patient satisfaction measures include easier access to specialists, reduced travel time, shorter appointment waiting times, improved care, effective interaction systems, accurate diagnoses, personalized care, culturally sensitive treatment and cost-effectiveness (Whitten & Love., 2005; Ho & Jarvis-Selinger, 2006). The generally positive attitude towards telehealth applications also challenges the assumption that older adults in particular may be unwilling or unable to operate certain types of equipment and technology (Bowles, 2007; Liddy et al., 2008). Any technology challenges for elderly populations appear to be alleviated as exposure increases (Ho & Jarvis-Selinger, 2006). Some patients, particularly in rural areas, view home-based telehealth applications as a lesser alternative to face-to-face consultations. However, patients generally believe that it is worthwhile to forego the high travel costs of seeing a particular specialist if they can efficiently access specialists using telehealth applications (Whitten & Love, 2005).

b) Self-Management & Behaviour Change

Home-based telehealth models often include self-management regimens and behavioural guidelines for patients. Since many home-based patients with chronic diseases are ultimately responsible for their own daily care, and are equipped to gauge their symptom severity and treatment efficacy, they are likely to benefit from selfmanagement regimens (Celler, Lovell & Basilakis, 2003). Patients with chronic diseases who have increased control over their condition become more informed about their chronic disease, which encourages patient empowerment - the most important outcome of telehealth in home-based settings (CHCA, 2008). Self-management regimens are rarely discussed in the literature on home-based chronic care telehealth interventions. Yet, when discussed, the evidence suggests that home-based telehealth applications can positively affect self-management for patients with heart failure, diabetes, hypertension or wounds (Bowles et al., 2007). For example, home-based telehealth applications for diabetes patients revealed that patients reported improvements in patient-caregiver interactions pertaining to information exchange and data transmission, and improved self-care in terms of blood glucose monitoring and understanding the disease (Verhoeven, 2007). When patients are positioned to actively contribute to their care, self-management is enhanced as patients begin to link their behaviours to clinical findings and provider feedback (CHCA, 2008).

Patient attitudes and behavioural outcomes are generally described in terms of their perceptions of technology; adherence to treatment (e.g. medications, regimens, etc); compliance with data entry systems; availability of additional support systems (e.g. patient education materials, behavioural change guidelines, support groups); and patient empo-

werment (Koch, 2005; Pare, Jenna & Sicotte, 2007; Liddy et al., 2008; Dorr et al., 2006). Chronic disease management through the use of home-based telehealth applications has been shown to improve behavioural change outcomes in patients with certain chronic diseases. For example, cardiac and hypertensive patients show high levels of compliance with data transfer and home-based telehealth applications. Other technology enabled interventions, such as web-based programs reveal a small to moderately large effect on patient knowledge and behavioural change outcomes, specifically in terms of: increased exercise time, improved nutritional knowledge, improved asthma treatment knowledge, increased healthcare participation, slower health decline, improved perception of body health and improved weight loss maintenance (Wantland, 2004). Despite these positive behavioural change outcomes, a decrease in adherence over time has been established in some cases (Pare, Jaana & Sicotte, 2007). Specific reasons for the lack of long-term adherence and factors associated with the sustainability of positive behavioural change are not established in the literature. The paucity of long-term effectiveness research in home-based telehealth applications for chronic diseases has led to fundamental concerns, namely, whether a telehealth system needs to be used indefinitely for patients with chronic diseases, or whether patients eventually learn to self-manage without the support of certain telehealth applications (Farberow et al., 2008).

b) Clinical Outcomes & Quality of Life

The impact of home-based telehealth applications on clinical outcomes is frequently cited in the literature. Among studies in this venue, clinical outcomes are discussed in 55% to 78% of the articles cited in any given systematic review (Barlow et al., 2007; Pare et al., 2007). This can be attributed to the noted shift in the literature's focus from 1990 (provider focused) to 2003 (patient focused) (Koch, 2005). A variety of clinical outcomes are often measured, including: laboratory values, data monitoring values, hospitalization frequencies, quality of life, etc. (Dorr et al., 2006). Although clinical outcomes are often reported, there are mixed findings in the effectiveness of telehealth on clinical outcomes and very limited findings on changes in overall quality of life (Hersh et al., 2006; Pare, Jaana & Sicotte, 2007). While it is generally held that telehealth does not have negative or adverse effects on clinical outcomes, the measured positive effects vary according to the study and chronic disease. Further to this, nonrandomized control trials are more likely to report positive clinical outcomes than randomized control trials (Dorr et al., 2006). These and other inconsistencies (e.g. small sample sizes) make it extremely difficult to form generalized assessments of clinical outcomes.

Systematic reviews focusing specifically on diabetes and heart disease are prevalent in the literature (Jaana and Pare, 2007; Chaudry et al., 2007; Verhoeven et al., 2007; Clark et al., 2007). The most effective home-based telehealth applications appear to be vital signs monitoring and telephone follow-up by nurses for patients with chronic diseases (Barlow et al., 2007). Below is a summary of the clinical outcome effectiveness reported for the four most widely represented chronic diseases in the literature:

1) Diabetes: Clinical outcomes are inconclusive (Pare, 2007; Garcia-Lizana & Sarria-Santamera, 2007; DelliFraine & Dansky, 2008; Barlow, Singh, Bayer & Curry, 2007). Home-based telehealth applications have been found to aid in reducing biochemical indicators, namely hemoglobin A1C, but the extent of telehealth's impact on other measurable outcomes such as medication adherence, blood glucose levels, complications, and hospital admissions remains unclear (Verhoeven, 2007). Most diabetes-based interventions focus on educating patients and monitoring biochemical indicators (e.g. blood glucose levels). Improvement in quality of life is observed in some studies on diabetes, namely in physical functioning, general health, emotional well-being, stress reduction and social functioning (Verhoeven, 2007; Bowles & Baugh, 2007).

2) Hypertension: Clinical outcomes are slightly more consistent and moderate. Telehealth monitoring on systolic

and diastolic blood pressure, medication adherence, and quality of life has resulted in favorable, although moderate, outcomes. Furthermore, telehealth monitoring has helped reduce the number of health centre visits. (Pare, 2007; Garcia-Lizana & Sarria-Santamera, 2007; DelliFraine & Dansky, 2008; Barlow et al., 2007).

3) Heart Conditions: For patients with pulmonary conditions, cardiovascular disease, and heart disease, home-based telehealth applications have resulted in a decrease in hospital admissions, emergency department visits, and hospital lengths of stay (Pare et al., 2007). Additionally home-based telehealth applications have increased efficient patient data transfer, and reduced mortality (Pare et al., 2007). Improvements in quality of life and a reduction of complications are inconsistent in the literature.

4) Asthma: Studies on asthma reveal that regular telephone calls from nurses to asthmatic patients improved clinical outcomes by lowering the amount of hospital admissions, lowering hospital costs, and reducing symptoms (Barlow et al., 2007). Evidence also suggests that home monitoring allows a greater proportion of asthmatic patients to be monitored at no additional health service cost (Barlow et al., 2007).

Clearly there are wide variations in the clinical outcomes of telehealth according to chronic disease. The inconsistent findings might be due to study limitations rather than to the shortcomings of telehealth interventions alone. More robust studies are needed. Still, the studies indicate that telehealth is potentially more useful for conditions that require close monitoring, clinical assessment and early intervention to avoid adverse events. Additionally, supporting the mental and physical needs of chronic disease patients at home can potentially improve quality of life by helping patients remain out of hospitals (Hjelm, 2005).

Canadian organizations providing telehealth services to patients – including those in the home setting - rarely perform comprehensive evaluations of telehealth applications. Indeed, only 46% of organizations either actively collected or were developing a collection process for clinical outcomes and cost-analysis data (Hogenbirk et al., 2006). Of those who were collecting data, the types of measures collected varied considerably between organizations. Typical patient based data points included eliminating patient/clinician travel, timeliness of health-care interventions, suitability of health care interventions for the patient's condition, provider-to-patient information sharing, correct diagnoses and patient satisfaction. These variations were largely dependent on the telehealth provider organizations (Hogenbirk et al., 2006).

iii) Providers

a) Uptake & Use of Technology

An important factor of home-based telehealth is for healthcare providers to have access to real-time information about their patients. Common ICTs used by providers in home care include a range of technologies from handheld devices (e.g. cellular phones, personal digital assistants, and pagers) to larger equipment (e.g. teleconferencing equipment, videoconferencing equipment, and computer technologies) (CHCA, 2008). ICTs to support frontline home care staff (e.g. nurses, personal support staff, and therapists) are more limited. These technological applications enable the rapid transmission of data which contributes to inter-disciplinary collaboration and quick access to specialists and patients. Additionally, home care providers use the internet to provide staff with educational information on policies, procedures and additional resources (CHCA, 2008).

Research on providers' uptake of home-telehealth technology has evolved from an enthusiastic focus on potential positive outcomes to a balanced view of successes and barriers of adopting home-based telehealth applications (Whitten & Love, 2005). While early research focused on technology implementation, more recent research focuses on program evaluation. This transition is greatly needed in telehealth research, yet actual uptake lags behind the corresponding evaluation research. Representative data on providers' uptake of home-based telehealth applications is extremely limited both nationally and internationally (Koch, 2005). Some programs used in Canada do illustrate the home-telehealth applications used by providers. For example, Healthphone developed a program for staff to use a secure handheld device at the point of care, which enables the instant electronic recording and transfer of clinical notes (CHCA, 2008). Another program provides staff with access to a web-based portal that provides continuing education modules, reference materials, and continuing certification programs. The portal could be used for both home and non-home-based care (CHCA, 2008). Information on provider uptake of telemonitoring technologies is rare. Studies on telemonitoring focus, for the most part, on clinical and behavioural outcomes/changes, not on provider perceptions or uptake (Chaudhry et al., 2007; Louis et al., 2003).

Explanations for the delay in widespread telehealth technology uptake are inconclusive. Research investigating this delay reveals that primary and specialist users and non-users of telehealth technology do not vary according to demographic characteristics or perceptions toward telehealth advantages, disadvantages, financial investment, and liability (Barton et al., 2006). However, provider telehealth users are more likely to practice in public clinics whereas non-users are more likely to work in private practice (Barton et al., 2006). Additionally, it was found that the majority of telehealth users are in the cardiology sector, indicative of a positive correlation between heart disease and telehealth applicability (Barton et al., 2006). While the literature on provider uptake of telehealth technologies is vague, accounts of provider perceptions towards telehealth applications are relatively explicit. Providers generally give significantly positive feedback on proposals to integrate telehealth into the healthcare system, and identify the following potential benefits: accurate diagnoses; expedited referrals; flexible timelines to examine high-quality diagnostic images and to provide expert opinions; and a reduction in travel (Whitten & Love, 2005). There may be bias in these studies due to their inclusion of early adopters, which is not necessarily transferable to the larger population. In terms of usability, healthcare providers are generally able to adjust to the new telehealth system, access the various functions, and successfully perform changes in patient care plans (Jaana & Pare, 2006). These benefits do not come without perceived barriers. Providers express concerns over the use of telehealth technology, namely in the areas of costs, workload, training needs, technological issues, and the potential lack of compensation (Jaana & Pare, 2006). One of the strongest cited barriers to implementation is reimbursing providers for time spent reviewing patient data, managing alerts, modifying care plans, and consulting with other health team members (Farberow et al., 2008). Increases in workload are also a specific concern to some healthcare professionals. For example, home-based telehealth applications may increase workload due to the patients' ability to continuously communicate with their providers (Jaana & Pare, 2006).

Proposed solutions to these perceived barriers include telehealth technology training sessions, financial incentives, government funding programs, and telehealth technology standards (Anderson, 2007). Unfortunately, details on decision-making, information assistance, and communication support for staff are sparse (Koch, 2006).

b) Primary & Specialist Integrated Care

Home-based telehealth applications enable a multi-disciplinary team of clinicians, healthcare staff and community healthcare workers to comprehensively assess and care for patients with chronic diseases. Communication between primary providers and specialists has traditionally been done through mail. New multidisciplinary teams can incorporate technologies to speed up the communication process and improve patient care. Email is increasingly sugge-

sted as an effective tool for the transmission of patient information between health professionals (Hjelm, 2005). Integrated care between health professionals using telehealth technology can result in fewer delays in patient care decision-making, time saved by both patients and health professionals, and ongoing provision of educational opportunities in a variety of settings (e.g. inter-hospital, intrahospital, and between primary and secondary centers) (Hjelm, 2005). In the context of chronic conditions, telehealth may also reduce unnecessary specialist referrals since specialists can quickly decide on the need for an appointment by immediately reviewing information provided through telehealth services (Whitten & Love, 2005). The impact of these conveniences on cost has yet to be examined in detail³.

Potential barriers in primary and specialist integrated care have been identified but not sufficiently explored. One suggested barrier is the decline in personal interactions between health professionals due to communication exclusively via technological devices (Hjelm, 2006). Although this barrier was cited in regards to non-home-based telehealth applications, it is clear that the decline in physician- to-physician interaction is a large concern to home-based telehealth as well. To counteract this potential problem, it might be worthwhile to consider the perceived competence of the practitioner on both ends of the system; in other words, trust amongst healthcare workers is an important component of a satisfactory telehealth system (Whitten & Love, 2005).

c) Improved Patient Management

Home-based telehealth applications support patients with chronic diseases by enhancing the providers' ability to manage and support care outside of the standard face-to-face clinical consultation process (Celler, Lovell, Basilakis, 2003; Meystre, 2005). In addition, telehealth applications are generally found to be quite effective in eliminating home visits. One study claims that 46-50% of randomly selected visits could have potentially been undertaken and successfully achieved via video-conferencing technologies (Hebert, Korabek & Scott, 2006). With streamlined processes for homebased telehealth applications, the provider can visit more patients, thus improving continuity, consistency and efficiency of care (CHCA, 2008).

Home-telehealth systems appear to enhance provider-patient communication and provide closer health monitoring compared to face-to-face consultations. Physicians reported that information derived from home-based telehealth applications is helpful in assisting with patient monitoring and assessing patient stability (Liddy et al., 2008). An associated benefit to this is the presumed improvement to accuracy and reliability of transmitted patient data. Still, even data input and transfer are seen to encounter nominal technical problems and errors (Pare et al., 2007; Meystre, 2005).

Nurses reported that home-based chronic care telehealth technology allowed them to create closer relationships with patients and efficiently monitor vital signs, both of which contribute to better patient care (Bowles & Baugh, 2007). Nurses also perceive telehealth technology to be a time and cost-saving method of monitoring vital signs. As a result, the increased productivity allows them to provide better patient care. A hometelehealth initiative in Ontario allows nurses to instantly extract inputs and processes from patient charts, thus enabling them to plan patient care based on the best patient outcomes (CHCA, 2008). Occasionally, however, the complexity of the technologies can frustrate healthcare personnel and provoke anxieties over proper usage and effective patient management (Bowles & Baugh, 2007). Patient perspectives appear to corroborate this last point. For patients, the quality of communication between provider and patient in telehealth settings is heavily dependent on the healthcare provider's comfort with the technical environment and equipment, as well as their general communication skills and the appropriateness of the clinical appli-

³ Explicit cost-benefit analyses of integrated, home-based monitoring are lacking. For example, a recent comprehensive report on the value of provider-to-provider telehealth excluded the context of telehealth technologies in the home (Cusack et al., 2007).

cation to the setting (Hogenbirk et al., 2006).

It is important to note that the reported patient management improvements are sometimes seen only with the help of additional staff and resources (Hersh et al., 2006). When evaluating the effectiveness of telehealth applications on patient management, the literature does not often distinguish between initiatives with essential criteria such as dedicated program staff or specific technologies. Providers also express concerns about their ability to help patients in a critical situation (Whitten & Love, 2005; Liddy et al., 2008). Physician apprehension appears to generally reside around issues of medicolegal liability, confidentiality, remuneration, the prompt reception of time-sensitive data, and the reliability of equipment; essentially any factor that could ultimately impact patient outcomes (Liddy et al., 2008).

iv) Policy

a) Telehealth Implications for Healthcare Policy

The literature is relatively sparse in terms of detailing specific policies on homebased telehealth. Instead, when policy is discussed, the literature tends to focus more generally on national or provincial level telehealth policies for service delivery in clinics and/or hospitals. Although policies on home-based telehealth are rarely discussed, they are nonetheless often affected by larger telehealth-wide policy decisions. Above all, critiques of current telehealth-care policy – or the lack thereof – dominate the literature. It would appear that, while telehealth projects are rapidly multiplying, policy to guide these initiatives is lagging behind (Donahue, 2006). The policy deficiency can be attributed, at least partially, to the lack of consistent, reliable, empirical data on outcomes of telehealth services. Without such information, policy makers, unsure of telehealth's potential for success, have stopped short of forming strong policies that could give stability to the field, provide incentive for investment, and fully integrate telehealth into the healthcare system (Miller, 2007). One study outlines the following five areas of policy that must be addressed before telehealth services can be utilized safely and efficiently: (1) effectiveness of patient management, (2) evidence-based outcomes, (3) regulation, (4) cost, including cost-effectiveness and reimbursement, and (5) certification of telehealth systems to ensure their reliability. Regulations need to be developed, gaps in the classification of technological devices need to be addressed, and services need to be standardized (Farberow et al., 2008).

The lack of national standards is also well-documented. As discussed earlier, the National Initiative for Telehealth Evaluation (NIFTE) created a 122-page literature review and report on the need for national telehealth standards, regulations and accreditation in Canada. In addition to assessing the state of Canadian telehealth in 2003, the report revealed that the lack of national standards was apparent and proceeded to make recommendations in five key areas. These included: clinical standards and outcomes; human resources; organizational readiness; organizational leadership; and technology and equipment. In these areas, NIFTE recommended that national standards be set and/or further research be undertaken. As a corollary, the report claimed that until national standards were set, health care institutions must form interim cross-jurisdictional policies in conjunction with institutions across Canada (National Initiative for Telehealth, 2003).

Telehealth services increase cross-border consultations between patients and healthcare personnel in separate jurisdictions. In this regard, the Canadian Society of Telehealth notes that the lack of telehealth policy causes liability and licensing concerns. For example, it is unclear whether physicians in B.C. adhere to their own province's licensing standards or to those of their patients in other jurisdictions. This is of particular concern in legal matters, where provinci-

al laws may vary and therefore result in ambiguity (Canadian Society of Telehealth, 2007).

International telehealth services are also growing despite differences in national licensure and quality assurance policies. In particular, global online pharmacies allow clients from all over the world to purchase pharmaceuticals at discounted rates, all from the comfort of their own home (Mclean and Mclean, 2008). There is ambivalence on the appropriate course of action, with some authors recommending that international telehealth activities should proceed with extreme caution until firm regulations are put in place, while others warn against strict regulation (National Initiative for Telehealth, 2003; Mclean and Mclean, 2008). In either case, international telehealth policy will have to be formed through the collaboration of national governments. The literature does not posit whether more traditional home telehealth services such as teleconsultation and telemonitoring are affected by this international cross-border activity.

Evaluating the readiness of communities, healthcare organizations, patients and providers to accept telehealth services is another concern for policy-makers, but the literature is rather vague in terms of providing useful models. While some readiness models have been presented, limitations still exist for each (Jennett et al., 2005). In particular, while there appears to be a heavy emphasis on provider readiness, organizational and patient readiness is particularly neglected (Jennett et al., 2005). In Canada, as many as 40% of healthcare personnel claim that their organization has telehealth-specific human resource plans; however, such organizational readiness relies on provider perceptions rather than on unbiased criteria, thereby limiting the effective assessment of organizational readiness (Hogenbirk et al., 2006). Researchers must establish standardized methods for evaluating readiness in different contexts if policymakers are to have the tools necessary to make firm decisions.

b) Telehealth Technologies & Healthcare Policy

Telehealth's dependence on telecommunications technologies means that the field is in a constant state of flux and evolution, making the creation of strong policies to regulate and standardize telehealth services more difficult (Sood et al., 2007). Particular aspects of how telehealth technologies affect the healthcare system are found in the literature. Information systems to support homecare for chronic illness have been found to be largely successful in terms of providing education and social support (Dorr et al. 2007). Yet despite their success in these areas, the benefits of these technologies for the long-term management of chronic diseases have yet to be supported by solid evidence (Garcia-Lizana & Sarria-Santamera, 2007).

Although tentative approval of telehealth technologies can be found, several barriers are also identified. For example, if remote areas are to be made accessible through telehealth services, telecommunications infrastructure must be developed in these areas. This co-dependency between telehealth and infrastructure also suggests that they must be developed simultaneously and symbiotically and, as such, new policies which can regulate this novel relationship are needed (Peddle, 2007). Telecommunications infrastructure has also been constructed on a piecemeal basis which has led to technologies that are not inter-operable (Miller, 2007). Technological security is another area which is particularly in need of policy and regulation. The technology must use authorization mechanisms to guarantee the safe and secure transfer of sensitive information from patient to provider and vice versa (Broens et al., 2007).

The implementation of effective telecommunications systems is not, however, believed to be sufficient for the proper functioning of telehealth services. New technologies cannot simply be introduced into a healthcare or homecare environment without providing proper training for staff and patients (Harnett, 2006). Training, technical support, usability and the quality of programs all need to be addressed for telehealth services and infrastructure to be successful

(Broens et al., 2007). Healthcare policymakers will have to deal with this new reality and create training programs and regulations, but since the responsibility to educate and regulate health professionals is a provincial/territorial duty, it is unclear how standardization will proceed (Hogenbirk et al., 2006). Lastly, standardized reporting of new technology outcomes would be extremely valuable to policymakers and provide them with the tools to address technological problems and policy deficiencies (Dorr et al., 2007).

While the problems posed by new telehealth technology to healthcare policy are discussed in detail, solutions to these problems are more difficult to find. The Canadian Home Care Association did make a number of recommendations on how to advance home care through the use of ICTs. Most of the recommendations focused on the need for increased funding and investment in infrastructure and technology. Other recommendations included the establishment of forums, roundtable discussions, as well as increased support for further research and existing programs (Canadian Home Care Association, 2008). Still, solutions to the specific problems around home-based telehealth applications (e.g. confidentiality, reimbursement, liability, etc.) are scarce.

c) The Impact of Telehealth Services on the Healthcare System

As the burden of chronic disease on the Canadian healthcare system increases, there is a growing belief that telehealth services can alleviate some of the pressure by increasing cost-effectiveness and reducing hospital admissions and stays (Jennett et al., 2003). On the other hand, it could be argued that the provision of telehealth to patients who do not have physical access to care may actually increase costs overall by increasing the provision of service. The benefits of telehealth services have, however, been studied from various perspectives and with diverse methodologies which in turn has led to inconsistent findings. In other words, the belief in telehealth's ability to unburden the Canadian healthcare system has yet to find consistent validation in the published literature. For example, one systematic review suggested that telehealth services were cost-effective in treating patients with chronic heart failure (Clark et al., 2007). Another review suggested that teleconsultation was a cost-effective method of delivering healthcare services to diabetics, but the range in study design and findings made forming a strong conclusion premature (Verhoeven et al., 2007). Barlow et al. (2007) found cost-effectiveness varied depending on the context and the disease, but noted that some studies showed no reduction in costs whatsoever.

Hebert et al. (2006) proposed that in order to accurately evaluate the complete cost of telehealthcare, the costs of project establishment, equipment, maintenance, communication, and staffing have to be assessed holistically. The challenge, however, is in collecting the data necessary to make such assessments (Hebert et al., 2006). Without this information, the task of creating new, informed policies is made more onerous. Complicating this process even further, the vast differences between telehealth contexts, diseases, and the technologies required to treat them hinders and devalues the formation of uniform evaluation methods and policies (Gagnon et al. 2005). Still, the cost-effectiveness of telehealth is increasing as the cost of equipment continues to fall and network connections become more affordable (Schaafsma et al., 2007). While this presumably bodes well for the growth of telehealth infrastructure in Canada, the everchanging landscape further complicates the process of evaluating the cost-effectiveness of telehealth services and denies policymakers the benefit of consistent, reliable data on which to base new policy.

The literature is also inconsistent in terms of evaluating telehealth's impact on hospital stays and admissions. Several home-based telehealth applications have been put in place to alleviate the burden of chronic diseases by reducing hospital admissions and nursing home visits (Hebert et al., 2006). One study suggested that telemonitoring for patients with chronic heart failure might not be very successful in reducing hospital admissions, but can result in shorter hospital stays (Clark et al., 2007). Another study observed that patients with pulmonary or cardiac diseases have notice-

ably decreased hospital admissions and length of hospital stays as a result of home telehealth initiatives, but such uniformity in outcomes was absent in the case of patients with diabetes (Pare et al., 2007). Hospital lengths of stay are said to be reduced due to improved multi-disciplinary patient management and continuity of patient care (Ho & Jarvis-Selinger, 2006). As with assessing cost-effectiveness, the evaluation of telehealth's impact on hospital stays and admissions is obscured by the variations in study methodologies and the variant technological requirements and treatment programs of particular diseases. In summary, policy-makers have difficult decisions to make, and very little consistent evidence to make them with.

c) Telehealth Implications for Health Human Resources

Overall, it is assumed that the implementation of general telehealth services will improve the retention and recruitment of physicians and other healthcare personnel to rural and/or remote regions. Strong evidence for such an assumption is, however, yet to be found in the literature. Seven categories of recruitment and retention factors which could be impacted by telehealth are identified in the literature: individual, familial, contextual, professional, organizational, educational and economic (Gagnon et al., 2007). Yet, even if telehealth services were successful in positively impacting the aforementioned recruitment and retention factors, telehealth services are not considered capable of independently solving the healthcare work shortages in rural and/or remote regions (Gagnon et al., 2007). The literature does not discuss what role home-based telehealth applications would play in solving or perpetuating these inequities. The establishment of home-based telehealth applications might be significant since an increase in home-based telehealth services to rural or remote regions might diminish the need for more healthcare personnel to physically re-locate, thereby hindering the recruitment of healthcare professionals to these areas.

The numerous barriers posed by the lack of telehealth regulation – namely, policies of reimbursement and confidentiality – are also discussed. In addition to those impediments, one study observed that physicians need to be convinced that telehealth services are beneficial for their own jobs/lives and not merely for their patients (Grigsby et al., 2007). How to demonstrate that fact to physicians and other healthcare personnel remains in question. Methods for convincing healthcare personnel have been suggested throughout the literature. For instance, physician recruitment is shown to be higher when aggressively pursued by health program administrators (Grigsby et al., 2007). Yet, conclusive evidence on telehealth and the retention and recruitment of healthcare personnel to rural and/or remote regions remains scarce. More long-term studies on telehealth and medical human resource management in remote and rural regions are needed (Gagnon et al., 2007).

Priority Research Questions

The priority research questions outlined below address each of the main subject areas of this scoping review and are drawn directly from the Results sub-sections. Purposely broad in scope, the questions are expected to stimulate further avenues for research on home-based telehealth applications.

i) Patients

Uptake & Use of Technology

- 1) How does patient uptake of home-based telehealth applications vary across geographical locations, chronic diseases, and patient groups?
- 2) Since age does not appear to be a factor, what specific factors inhibit or promote patient uptake and use of home-

based telehealth technologies?

Self-Management & Behaviour Change

- 3) What are the long-term effects of home-based telehealth applications on behavioural change, clinical outcomes and patient self-management?
- 4) Does adherence to self-management regimens and behavioural change vary across chronic diseases?

Clinical Outcomes & Quality of Life

- 5) What explanations can be given for the inconsistencies in patient clinical outcomes, particularly for diabetic patients (e.g. factors other than study design)?
- 6) What is the impact of home-based telehealth applications on quality of life (e.g. social isolation, stress, poverty and other social conditions)?
- 7) Are home-based telehealth applications more useful for chronic diseases that require close monitoring and early intervention as opposed to those that do not?

ii) Providers

Uptake & Use of Technology

- 1) What are the reasons for the lack of widespread provider uptake of telehealth technologies?
- 2) What are the necessary conditions and contextual factors that lead to support systems that encourage and properly train health professionals to use homebased telehealth technologies?

Primary & Specialist Integrated Care

- 3) What is the cost-benefit analysis of integrated care in home-based telehealth in Canada?
- 4) How can relationships between healthcare providers in integrated telehomecare settings be developed in order to facilitate and ensure trust, compatibility, and cooperation?

Improved Patient Management

- 5) What are the benefits and drawbacks of home-based telehealth patient management as compared to face-to-face home visits?
- 6) What additional criteria would contribute to the success and effectiveness of home-based telehealth services (e.g. supplementary staff, specific technologies etc.)?

ii) Policy

Telehealth Implications for Healthcare Policy

- 1) To what extent are policy-makers affected by the lack of substantive, consistent research findings in some areas of telehealth? Is the surplus of research on telehealth applications pertaining to heart disease and diabetes the only reason for the increased implementation of telehealth in those particular chronic disease contexts?
- 2) What types of specific evaluation processes can aid in the formation of homebased telehealth policy?

Telehealth Technologies and Healthcare Policy

- 3) What role does the telecommunications industry play in spurring or hindering the creation of new policy?
- 4) To what extent does policy hinder the uptake of telehealth technologies? The Impact of Telehealth Services on the technologies in use, or a combination therein?

The Impact of Telehealth Services on the Healthcare System

5) Are the inconsistencies in findings on hospital stays and admissions a result of study design, disease specificities,

Telehealth Implications for Health Human Resources

6) Does the establishment of home-based telehealth applications help or hinder the recruitment of health professionals to rural and/or remote areas?

7) How are policy-makers dealing with issues of reimbursement and confidentiality for home-based telehealth applications?

Conclusion

Although the literature on telehealth is vast and in a consistent state of growth, this scoping review has demonstrated that the research on home-based telehealth applications is far from comprehensive, particularly in the Canadian context. Certainly, the evaluated literature has provided a variety of determinants which influence the success of home-based telehealth applications. Yet, in all three of the categories outlined – patient, provider and policy – a multitude of significant questions remain unanswered. The priority research questions elucidated by this scoping review outline important research gaps and elucidate possible avenues for future research on homebased telehealth applications.

References

- Anderson, J. (2006). Social, ethical and legal barriers to e-health. *International Journal of Medical Informatics*, 76, 480-483.
- Alvarez, R. (2002). The promise of e-health – a Canadian perspective. *EHealth International*, 1(4).
- Barlow, J., Singh, D., Bayer, S., & Curry, R. (2007). A systematic review of the benefits of home telecare for frail elderly people and those with long-term conditions. *Journal of Telemedicine and Telecare*, 13, 172-179.
- Barton, P., Brega, A., Devore, P., Mueller, K., Paulich, M., Floersch, N., Goodrich, G., Talkington, S., Bontrager, J., Grigsby, B., Hrinkevich, C., Neal, S., Loker, J., Araya, R.,
- Bennett, R., Krohn, N., Grigsby, J. (2006). Specialist physicians' knowledge and beliefs about telemedicine: A comparison of users and nonusers of the technology. *Telemedicine and e-Health*, 13(5), 487-499.
- Bowles, K., Baugh, A. (2007). Applying research evidence to optimize telehomecare. *Journal of Cardiovascular Nursing*, 22(1), 5-15.
- Broens, T., Huis in't Veld, R., Vollenbroek-Hutten, M., Hermens, H., Van Halteren, A., Nieuwenhuis, L. (2007). Determinants of successful telemedicine implementations: A literature study. *Journal of Telemedicine and Telecare*, 13, 303-309.
- Canada Health Infoway. (2006). Telehealth Scheduling Systems Environmental Scan Summary. Retrieved August 13, 2008, from http://www.infowayinforoute.ca/Admin/Upload/Dev/Document/TH%20RFI%20Appendix%203%20Environmental%20Scan_EN.pdf
- Canadian Home Care Association. (2008). Integration through Information Technology for Home Care in Canada. Retrieved September 22, 2008 from <http://www.cdnhomecare.ca/>
- Canadian Society of Telehealth. (2007). Telehealth – What the Future Holds: A White Paper produced by the Canadian Society of Telehealth. Retrieved August 13, 2008, from http://www.cst-sct.org/en/index.php?module=library&VV_DocumentManager_op=downloadFile&VV_File_id=316
- Celler, B., Lovell, N., Basilakis, J. (2003). Using information technology to improve the management of chronic disease. *The Health Care System*, 179, 242-246.
- Chaudhry, S., Phillips, C., Stewart, S., Riegel, B., Mattera, J., Jerant, A., Krumholz, H. (2007). Telemonitoring for patients with chronic heart failure: A systematic review. *Journal of Cardiac Failure*, 13(1), 56-62.
- Clark, R., Inglis, S., McAlister, F., Cleland, J., Steward, S. (2007). Telemonitoring or structured telephone support programmes for patients with chronic heart failure: Systematic review and meta-analysis. *British Medical Journal*, 10.
- Cloutier, A. (2004). Telehealth and Canada: A good fit. *Telemedicine Journal and e-Health*, 10(1), 1-2.

- Cusack, C., Pan, E., Hook, J., Vincent, A., Kaelber, D., Bates, D., Middleton, B. (2007). *The Value of Provider-to-Provider Telehealth Technologies*. Centre for Information Technology Leadership: Charlestown, MA.
- DelliFrane, J., Dansky, K. (2008). Home-based telehealth: A review and meta-analysis. *Journal of Telemedicine and Telecare*, 14, 62-66.
- Donahue, M., Dixon, M. (2006). Regulating Telehealth in Ontario – Next Step in the Transformation Agenda. *Telehealth Law*, 6(2), 17-44.
- Dorr, D., Bonner, L., Cohen, A., Shoai, R., Perrin, R., Chaney, E., Young, A. (2006). Informatics systems to promote improved care for chronic illness: A literature review. *Informatics Systems for Chronic Illness*, 14, 156-163.
- Farberow, B., Hatton, V., Leenknecht, C., Goldberg, L., Carlton, A. (2008). Caveat emptor: The need for evidence, regulation, and certification of home telehealth systems for the management of chronic conditions. *American Journal of Medical Quality*, 23, 208-214.
- Gagnon, M.P., Scott, R. (2005). Striving for evidence in e-health evaluation: Lessons from health technology assessment. *Journal of Telemedicine and Telecare*, 11, 34-36.
- Gagnon, M.P., Duplantie, J., Fortin, J.P., Landry, Rejean. (2007). Telehealth and the recruitment and retention of physicians in rural and remote regions: A Delphi study. *Canadian Journal of Rural Medicine*, 12(1), 30-36.
- Gagnon, M.P., Duplantie, J., Fortin, J.P., Landry, Rejean. (2007). Exploring the effects of telehealth on medical human resources supply: a qualitative case study in remote regions. *BMC Health Services Research*, 7(6), 1-9.
- Garcia-Lizana, F., Sarria-Santamera, A. (2007). New technologies for chronic disease management and control: A systematic review. *Journal of Telemedicine and Telecare*, 13, 62-68.
- Grigsby, B., Brega, A.G., Bennett, R.E., Devore, P.A., Paulich, M.J., Talkington, S.G., et al. (2007). The Slow Pace of Interactive Video Telemedicine Adoption: The Perspective of Telemedicine Program Administrators on Physician Participation. *Telemedicine and E-health*, 13(6), 645-656.
- Hebert, M., Korabek, B., Scott, R. (2006). Moving research into practice: A decision framework for integrating home telehealth into chronic illness care. *International Journal of Medical Informatics*, 75, 786-794.
- Hersh, W., Hickam, D., Severance, S., Dana, T., Krages, K., Helfand, M. (2006). Diagnosis, access and outcomes: Update of a systematic review of telemedicine services. *Journal of Telemedicine and Telecare*, 12, 3-31.
- Hjelm, N. (2006). Benefits and drawbacks of telemedicine. *Journal of Telemedicine and Telecare*, 11, 60-70,
- Ho, K., Jarvis-Selinger, S. (2008). Identification of best practices for evidence-based telehealth in British Columbia. Retrieved September 22, 2008 from <http://www.phsa.ca/NR/rdonlyres/942D0A17-4A53-481A-B11D-6E67F07C9B5B/21660/PHSALiteratureReviewPrimaryDocument.pdf>
- Hogenbirk, J., Brockway, P., Finley, J., Jennett, P., Yeo, M., Parker-Taillon, D., Pong, R., Szpilfogel, C., Reid, D., MacDonald-

- Rencz, S., Craddock, T. (2006). Framework for Canadian telehealth guidelines: Summary of the environmental scan. *Journal of Telemedicine and Telecare*, 12, 64-70.
- Jaana, M., Pare, G. (2007). Home telemonitoring of patients with diabetes: A systematic assessment of observed effects. *Journal of Evaluation in Clinical Practice*, 13, 242-253.
- Jennett, P.A., Scott, R.E., Affleck Hall, L., Hailey, D., Ohinmaa, A., Anderson, C., Thomas, R., Young, B., Lorenzetti, D. (2004). Policy Implications Associated with the Socioeconomic and Health System Impact of Telehealth: A Case Study from Canada. *Telemedicine Journal and E-health*, 10(1), 77-83.
- Jennett, P.A., Gagnon, M.P., Brandstadt, H.K. (2005) Preparing for success: Readiness models for rural telehealth. *Journal of Postgraduate Medicine*, 51(4), 279-285.
- Jennett, P.A., Affleck Hall, L., Hailey, D., Ohinmaa, A., Anderson, C., Thomas, R., Young, B., Lorenzetti, D., Scott, R.E. (2003). The socio-economic impact of telehealth: a systematic review. *Journal of Telemedicine and Telecare*, 9, 311-320.
- Koch, S. (2005). Home telehealth – Current state and future trends. *International Journal of Medical Informatics*, 1-12.
- Liddy, C., Dusseult, J., Dahrouge, S., Hogg, W., Lemelin, J., Humbert, J. (2008). Telehomecare for patients with multiple chronic illnesses. *Canadian Family Physician*, 54, 58-65.
- Louis, A., Turner, T., Gretton, M., Baksh, A., & Cleland, J. (2003). A Systematic Review of Telemonitoring for the Management of Heart Failure. *The European Journal of Heart Failure*, 5, 583-590.
- Mclean, T., Mclean, P. (2007). Is a black market in telemedicine on the horizon? *The International Journal of Medical Robotics and Computer Assisted Surgery*, 3, 291-296.
- Meystre, S. (2005). The current state of telemonitoring: A comment on the literature. *Telemedicine and e-Health*, 11(1), 63-68.
- Miller, E.A. (2007). Solving the disjuncture between research and practice: Telehealth trends in the 21st century. *Health Policy*, 82, 133-141.
- National Initiative for Telehealth. (2003). National Initiative for Telehealth (NIFTE) Framework of Guidelines. Retrieved August 13, 2008, from http://www.cstsct.org/en/index.php?module=library&VV_DocumentManager_op=downloadFile&VV_File_id=54
- Ohinmaa, A. (2006). What lessons can be learned from telemedicine programmes in other countries? *Journal of Telemedicine and Telecare*, 12, 40-44.
- Pare, G., Jaana, M., Sicotte, C. (2007). Systematic review of home telemonitoring for chronic diseases: The evidence base. *Journal of the American Medical Informatics Association*, 14(3), 269-277.
- Peddle, K. (2007). Telehealth in context: Socio-technical Barriers to Telehealth Use in Labrador, Canada. *Computer Supported Cooperative Work*, 16, 595-614.

- Provincial Health Services Authority (2008). <http://www.phsa.ca/AgenciesServices/Services/Telehealth/default.htm>
- Schaafsma, Joseph., Pantazi, S.V., Moehr, J.R., Anglison, C.R., Grimm, N.A. (2007). An economic evaluation of a telehealth network in British Columbia. *Journal of Telemedicine and Telecare*, 13, 251-256.
- Sood, S., Mbarika, V., Jugoo, S., Dookhy, R., Doarn, C., Prakash, N., Merrell, R. (2007). What is telemedicine? A collection of 104 peer-reviewed perspectives and theoretical underpinnings. *Telemedicine and E-Health*, 13, 573-591.
- Vasquez, M. (2008). Telehealth and home healthcare nursing. *Home Healthcare Nurse*, 26(5), 281-287.
- Verhoeven, F., Gemert-Pijnen, L., Dijkstra, K., Nijland, N., Seydel, E., Steehouder, M. (2007). The contribution of teleconsultation and videoconferencing to diabetes care: A systematic literature review. *Journal of Medical Internet Research*, 9(5)
- UBC Health Library Wiki (2008) Retrieved August 13, 2008, from http://hlwiki.slais.ubc.ca/index.php?title=Systematic_review_searching
- Wantland, D., Portillo, C., Holzemer, W., Slaughter, R., McGhee, E. The effectiveness of web-based vs. non-web-based interventions: A meta-analysis of behavioral change outcomes. *Journal of Medical Internet Research*, 6(4). <URL: <http://www.jmir.org/2004/4/e40/>>
- Whitten, P., Johannessen, L., Soerensen, T., Gammon, D., Mackert, M. (2007). A systematic review of research methodology in telemedicine studies. *Journal of Telemedicine and Telecare*, 13, 230-235.
- Whitten, P., Love, B. (2005). Patient and provider satisfaction with the use of telemedicine: Overview and rationale for cautious enthusiasm. *Journal of Postgraduate Medicine*, 51(4), 294-300.

Appendix A

Search Strategy

Database/ Journal	Database/ Journal Description	Search Restrictions
MEDLINE	Biomedicine and health database encompassing the life sciences, behavioral sciences, chemical sciences, and bioengineering needed by health professionals and others engaged in basic research and clinical care, public health, health policy development, or related educational activities.	Time Frame: 2003-2008 Language: English
EMBASE	Biomedical and pharmaceutical database indexing over 3,500 international journals in drug research, pharmacology, pharmaceuticals, toxicology, clinical and experimental human medicine, health policy and management, public health, occupational health, environmental health, drug dependence and abuse, psychiatry, forensic medicine, and biomedical engineering.	
CINAHL	Authoritative coverage of the literature related to nursing and allied health.	
Web of Science	Consists of Science Citation Index Expanded; Social Sciences Citation Index; and Arts and Humanities Citation Index.	
Journal of Telemedicine and Telecare	Leads the coverage of developments in telemedicine and e-health. Sections within the journal include technology updates, editorials, original articles, research tutorials, educational material, review articles and reports from various telemedicine organizations.	
Google Scholar	Grey literature will be searched using Google Scholar, BC Ministry of Health, Health Canada, BC College of Physicians and Surgeons Library, and various tele-health groups for published policy and government documents.	Limits: First 5 pages of search results

Patient Search Terms:

(telehealth or telemedicine or telemonitoring or telenursing or telerehabilitation or ehealth or e-health or self-monitoring or web-based) and (patient*) and (self-manage* or self-monit* or "quality of life" or change or behavio* or monitor* or equity) and/or review articles or Canada.

Provider Search Terms:

(telehealth or telemedicine or telemonitoring or telerehabilitation or telenursing or ehealth or e-health or self-monitoring or web-based) and (provider* or practitioner* or physician*) and (uptake or use or "patient manag*" or integrated or specialist* or equity) and/or review articles or Canada

Policy Search Terms:

(telehealth or telemedicine or telemonitoring or telerehabilitation or telenursing or ehealth or e-health or self-monitoring or web-based) and (policy or decision-maker* or strateg* or legislation or guideline* or procedur* or regulation* or standard* or barriers or equity) and ("review articles") and (evidence* base*)

Review Article Search Terms:

(telehealth or telemedicine or telemonitoring or telerehabilitation or telenursing or ehealth or e-health or self-monitoring or web-based) and (chronic disease or chronic care or chronic disease manage* or home-based or equity) and ("review articles")

