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FINAL REPORT

Socio-Economic Impact of Telehealth: Evidence Now for Health Care in the Future

Volume One: State of the Science Report

A report prepared by the
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I EXECUTIVE SUMMARY

Telehealth has become widespread in the last two decades, despite the fact that scientific evidence to support its use has often been lacking. This study was undertaken to contribute to the Alberta Heritage Foundation for Medical Research (AHFMR) 'State of the Science Reviews' program, and provides an information base to assist policy- and decision-makers, and researchers, in their deliberations about telehealth. It supercedes other telehealth meta-analyses due to its focus on the social, as well as the economic, impact of such technologies. Further, this study is unique in that it provides two documents that are closely linked – a State of the Science Report, and an accompanying Policy Report. This is the first such combined Report to date.

Telehealth, telemedicine, or e-health is defined as "the use of information and communication technology (ICT) to deliver health services, expertise and information over distance, geographic, time, social and cultural barriers." Telehealth encompasses Internet or web-based "e-health", as well as video-based applications. Applications can be real-time or store-and-forward.

This report summarizes the health services scientific and policy literature on telehealth. Based upon a comprehensive literature search and a critical review and appraisal of that literature, the report provides an overview of the strengths and weaknesses in the telehealth research base, identifies gaps in the existing knowledge, and reviews policy implications. Specifically, this study addresses the following questions:

1. What is the socio-economic impact of telehealth as a method of delivery of healthcare and information, compared to that of the status quo? For patients and their families? For providers, programs, institutions and regional health authorities? At the provincial and national levels? For the public in general?
2. What are optimal indicators and proxy indicators for the assessment of the impact of telehealth?
3. What are related recommendations for policy and decision makers?

The report consists of three volumes. Volume One describes the general areas of health benefit supported by proven telehealth applications from the literature. Volume Two summarizes the

related policy implications and recommendations, and Volume Three provides appendices that summarize the literature and support Volumes One and Two.

1. Socio-economic impact of telehealth

Telehealth has been found to offer important quality of life, health, and socio-economic benefits to the people of Alberta and Canada and to reduce costs and utilization of the healthcare system.

Based upon existing literature, a total of 14 social determinants of health or socio-economic performance indicators for a community were identified for this study. Of these, the study identified nine areas of socio-economic benefit as most prominent in the telehealth literature: Access, Cost / Cost Effectiveness / Decreased Health Services Utilization, Education, Support, Social Isolation, Acceptability / Satisfaction, Health Outcomes, Quality of Care, and Quality of Life. Ten subject areas, representing the most promising areas of telehealth application, were identified for study: Geriatrics, Paediatrics, First Nations, Telerehabilitation, Tele-mental health, Teleradiology, Rural / Remote, Tele-homecare, Renal, and Systematic Reviews of telehealth. The literature demonstrates varying levels of scientific evidence of socio-economic benefit in various telehealth applications across these subject areas. The subject specific recommendations provided in this review reflect the areas where the greatest impact of telehealth can be achieved, based on this evidence.

2. Optimal indicators and proxy indicators

A variety of outcome measures have been documented in the literature (access, quality of life, satisfaction, cost), but no studies clearly identified or defined specific socio-economic indicators of outcome. At this time there is no agreement on which quantitative or qualitative measures (i.e. outcome indicators) are appropriate, or of most value, when evaluating telehealth applications. The indicators screened for in this review based upon accepted determinants of health, but these are not as yet reflected as formal indicators in the telehealth literature. This study found no consistency in the identification or application of such indicators within, or between, studies in any subject area. Cost, cost savings or cost effectiveness were of common interest to many studies, but measurement of these were not consistent, with many studies using estimates as opposed to solid economic analysis. Moreover, benefits and costs were evaluated from different

points of view, for instance, the health system point of view versus the wider societal point of view. As a result there is uncertainty as to the general applicability of some study data, and direct comparison of one study with another may be misleading. This finding highlights a critical gap in our current research process and capabilities. Appropriately focused research questions and designs, validated instruments and defined quantitative or qualitative measures are required.

3. Recommendations for policy and decision makers

Based upon the evidence available, this study identified 40 general and subject-specific recommendations. Subsequent review found these to be congruent or complementary to Alberta and Federal health reform initiatives described in the recent Mazankowski, Kirby, and Romanow reports, each of which call for change and reform, not maintenance of the current structure. Telehealth is seen as an enabler of change and an innovative means of enhancing health care and health care delivery.

General recommendations arising from this study are:

A. Policy

1. To be successful and sustainable, telehealth must be fully integrated into existing health structures and processes in a practical and policy manner.
2. Integration can be achieved through aligning telehealth initiatives with existing strategic health plans, policy goal-setting, accompanying action steps, and resolution of policy barriers.
3. Establishment of a policy forum that focuses on telehealth policy would facilitate these needs.
4. Telehealth applications should incorporate capacity for education, research, and administrative functions, as well as health and clinical functions.
5. Federal-provincial/territorial partnerships in telehealth should be established where there are opportunities to improve efficiency in health care and decrease duplication.
6. As telehealth continues to evolve, input from all key stakeholders (including patients, health care providers, and the public) into policy development is required. Consideration of needs as well as practical experience is essential for a meaningful exchange of information and views.

7. Consistent terminology and definitions around telehealth, e-health and related terms should be adopted across jurisdictions.

B. Technology

8. To facilitate access to many bandwidth intensive telehealth applications increased broadband connectivity is needed, particularly to rural and remote communities.
9. Given the evidence, the use of telephone-based telehealth applications should be re-examined.
10. Technology modalities (broadband, narrowband, web-based) and applications (videoconferencing, data monitoring, telephone) should be viewed as synergistic, not competitive, and the most appropriate tool applied; i.e., hybrid connectivity solutions are recommended.

C. Evaluation

11. Suitable outcome indicators, measures, and reliable and valid instruments for socio-economic benefit of telehealth must be identified, defined, and consistently applied within a recognized evaluation framework that asks relevant research questions.
12. Suitable frameworks for economic analysis need to be developed that capture non-monetary and unintended consequences, as well as monetary measures.
13. Telehealth programs should be implemented and evaluated in a culturally aware and culturally sensitive manner.
14. Evaluations should include examination of the social, organizational, and policy aspects of telehealth.

D. Economic

15. Telehealth demonstrates sufficient evidence of socio-economic benefit to indicate ongoing investment is appropriate.
16. Sustainable telehealth ‘programs’ and not ‘projects’ should be targeted.
17. Full integration of telehealth will increase its use and decrease the per contact episode cost.
18. Investment in information and communications technology infostructure should be considered as an investment not only in health, but in business, education, and other e-sectors.

E. Investment Opportunities

19. R & D and economic development opportunities require pursuit.

Subject-specific recommendations arising from this study are as follows:

Paediatric Telehealth (SOS pp. 26-31)

20. Telehealth programs that improve quality of care and offer economic benefit for 'at risk' paediatric populations (e.g., neonates, adolescent asthmatics) should be introduced.
21. Telehealth programs that improve quality of care and offer economic benefit for 'at risk' paediatric populations (e.g., neonates, adolescent asthmatics) should be introduced.
22. Evidence would suggest decision makers should consider telehealth to achieve enhanced social environments for children, and staff efficiencies as related to data transfer.
23. The use of low-cost technology solutions (e.g., the telephone) is strongly recommended for Paediatric telehealth where appropriate.

Geriatric Telehealth (SOS pp. 32-39)

24. Telehealth programs should be used to support palliative home care initiatives.
25. Remote, wireless monitoring (e.g., personal alerts, caregiver and patient support, 'smart' homes and clothing) should be investigated for both enhanced independent living and geriatric healthcare applications.
26. Geriatric telehealth applications should be strongly considered as a technology R & D and economic development opportunity.
27. The use of e-prescription applications should be used to increase self-efficacy and compliance, and to reduce adverse effects.
28. The use of low-cost technology solutions (e.g., the telephone) is strongly recommended for Geriatric telehealth where appropriate.

First Nations Telehealth (SOS pp. 40-44)

29. The recommendations provided in the Health Transition Fund project report of 2001 (Health Canada) should be implemented, viz:
    - Increase connectivity to rural and remote communities, and especially Aboriginal communities;
    - Undertake new research further to implementation of successful telehealth initiatives in First Nations and Inuit communities, and regarding the impact of telehealth on costs, health services and human resources;

- Promote equality of opportunity for telehealth across First Nations and Inuit communities;
- Increase awareness and understanding of telehealth opportunities among First Nations and Inuit stakeholders;
- Create linkages between telehealth and other initiatives of the Aboriginal Health Infostructure in order to leverage investments.

30. Health services and information content should be delivered in a culturally sensitive context.

Tele-homecare (SOS pp. 45-50)

31. Telehealth should be considered for application in managing and monitoring chronic heart failure, chronic obstructive pulmonary disease, oncology, diabetes, wound care, asthma, anxiety, and cardiovascular accident.
32. Home Telehealth programs should be used to assist with and transform the mode of delivery of home care. Such programs should be used to support change within the context of the continuum of care, and a comprehensive home healthcare program.

Tele-mental health (SOS pp. 51-54)

33. Tele-mental health, a proven and sustainable telehealth application, should be expanded.
34. The use of low-cost technology solutions (e.g., the telephone) is strongly recommended for tele-mental health where appropriate.

Teleradiology (SOS pp. 55-59)

35. Teleradiology, a proven and sustainable telehealth application in settings of appropriate workload and distance, should be expanded.
36. Teleradiology should be adopted in settings where the need to travel or poor speed of care provision present barriers to access.

Renal Dialysis Telehealth (SOS pp. 60-62)

37. Teledialysis should be evaluated more comprehensively before commitment is made.

Rural and Remote Telehealth (SOS pp. 63-67)

38. Increased access to a broad range of clinical and educational resources should be provided to rural, remote, and underserved populations.
39. Enhanced connectivity to rural and remote communities and residences should be a priority to improve economies of scale in future service and information delivery.

Telerehabilitation (SOS pp. 68-73)

40. Telerehabilitation, which has been demonstrated to show benefits for health care and patients (e.g., speech pathology, transtelephonic exercise monitoring) requires more comprehensive economic analysis.

Conclusions

Overall, valuable data and levels of evidence exist that support telehealth, and that can now be used by policy makers, decision makers, and researchers when making decisions specific to telehealth. These have been summarised in this report. However, evidence of high scientific quality for telehealth applications is still lacking. What has been clearly demonstrated is the feasibility of using telehealth in many clinical areas and for many health, clinical, educational, research, and administrative activities. Many of the same policy and research concerns, issues, and challenges in telehealth that are discussed in current sources existed 10 years ago. These issues should be addressed and decisions made.

Successful and sustainable implementation of telehealth exists when there is greater integration with other information and communications technology initiatives, policy goal-setting, accompanying action steps, and attention to policy barriers. Benefits and successes often result when strategies and planning adopt human resource and user frameworks. For example, health and medical workforce and workflow are issues, together with readiness and ethical considerations. Collaboration, partnership and sharing are central to the advancement and sustainability of telehealth and its potential benefits, as are needs identification, risk assessment, enabling policy, and true public involvement.

Although project findings to date show broad benefits, these are generally associated with feasibility activity, and seldom measure the impact of telehealth on the social determinants of health, for example, poverty, social isolation, independent living, and identified needs of special populations. New evaluation and research activities should employ methodologies which enable the study of such factors. The reviewed literature suggests that the principal driving forces for telehealth have been financial, specialist clinical interest, and proof of technological feasibility. Patients' views and interests, social effects, quality controls and wider organizational effects are seldom considered. Our study shows that there are a growing number of evaluation frameworks

for use by policy makers and planners that could be consistently applied; for example, generic evaluation frameworks, benefit-cost analysis and consumer care pattern guidelines, as well as effects-oriented and risk analysis frameworks.

Integration, enablement of telehealth, and recognition and consistent evaluation of the significant potential benefits of telehealth, will greatly enhance health and socio-economic advantages for Canadians.

II INTRODUCTION

Telehealth has become widespread in the last two decades, despite the fact that scientific evidence to support its use has often been lacking. This study was undertaken to contribute to the Alberta Heritage Foundation for Medical Research (AHFMR) 'State of the Science Reviews' program, and provides an information base to assist policy- and decision-makers, and researchers, in their deliberations about telehealth. This State of the Science Report supercedes other telehealth meta-analyses due to its focus on the social, as well as the economic, impact of such technologies. Further, this study is unique in that it provides two documents that are closely linked – a State of the Science Report, and an accompanying Policy Report. This is the first such combined Report to date.

Telehealth has been found to offer important quality of life, health and socio-economic benefits to the people of Alberta and Canada, and can reduce costs and utilization in the health system. This study describes the kinds of benefits that can be achieved and how. Specifically, this study addresses the following questions:

1. What is the socio-economic impact of telehealth as a method of delivery of healthcare and information, compared to that of the status quo? For patients and their families? For providers, programs, institutions and regional health authorities? At the provincial and national levels? For the public in general?
2. What are optimal indicators and proxy indicators for the assessment of the impact of telehealth?
3. What are related recommendations for policy and decision makers?

Terminology in the field of telehealth is evolving with increasing global information-sharing and the growing presence of electronic media in the everyday lives of patients, the public and health providers. For the purposes of this study, telehealth, telemedicine, or e-health are used interchangeably and are defined collectively as "the use of information and communication technology (ICT) to deliver health services, expertise and information over distance, geographic, time, social and cultural barriers"(Reid, 1996). Telehealth encompasses Internet or web-based "e-health", as well as video-based applications. Applications can be live (real-time) or store-and-forward.

The range of ICTs used in the delivery of telehealth includes:

- Telephone, also referred to in some studies as "plain old telephone service" or POTS,
- Videoconferencing,
- Image capture and transfer,
- Internet or Internet protocol (IP)-based / web-based applications.

Telehealth delivery may be supplemented by decision support software or other information/education sources.

Socio-economic indicators include social determinants of health: poverty, social isolation, education, life stress, early life, access to transport, nutrition, access to health services and care; and factors affecting the socio-economic performance of a community: economy, labour markets, innovation, environment, education, health.

The context for this study is the Canadian health care environment with its particular characteristics, including universal access to health care, a population that is aging, widely dispersed (rural / remote), and diverse in composition with varying health needs (e.g., First Nations). Also implied in the study context is consideration of current strategic policy directions in the Albertan/Canadian health sector, such as the principles of providing care at the right time in the right place by the right provider, maintaining individuals' independence and community living, providing consumer choice, and trialing innovative projects in service delivery. These concepts, as well as the study investigators' experience and informed opinion regarding areas of promise for telehealth, led to the development of ten subject areas of focus for this study. These are:

1. Paediatrics telehealth
2. Geriatrics telehealth
3. First Nations telehealth
4. Tele-homecare
5. Tele-mental health
6. Teleradiology
7. Renal dialysis telehealth
8. Rural and remote telehealth
9. Telerehabilitation
10. Telehealth Reviews

A systematic review of the literature in each of these areas was undertaken, as well as a formal economic analysis of all pertinent articles within each subject area. In addition, a review of policy-related articles and sources was completed.

The study consists of three volumes:

Volume One: State of the Science Report. The State of the Science Report contains a description of the literature search strategy and the process established for selecting and reviewing sources, and a thorough analysis of the literature in each of the subject areas, including systematic reviews. It also incorporates an economic analysis, organized and summarized by subject area, and a series of recommendations drawn from both reports.

Volume Two: Policy Report. This report includes background information on Alberta, Canada, and global telehealth policy, a summary of the results of the State of the Science Report, a description of the policy development process (the policy awareness and engagement process as well as the review process for the policy articles/sources), results of the policy review, and recommendations drawn from both reports.

Volume Three: Appendices. This volume contains four issues of appendices supporting Volumes One and Two. The appendices include detailed information about the study process and a systematic review of all articles in each subject area, as well as all economic- and policy-related articles included in this study.

III LITERATURE SEARCH STRATEGY

The literature search strategy was led by the project librarian, in consultation with the other project team members. The literature search encompassed both peer-reviewed journals and the grey literature. Electronic database searching, communication with experts in the field, hand-searching of conference proceedings, along with Internet searches targeting individual organization and government web sites were among the key approaches used to identify literature relevant to this study.

The search strategy incorporated the following elements:

A. Electronic database searches

Subject and text words used in searching databases, as well as databases searched, are listed in Appendix B, pp. 1-7. Limits applied to searches were:

1. Language limits: eliminate Asian languages but retrieve all other non-English articles that include English language abstracts.
2. Publication date from 1980 to present

Studies captured in the preliminary database search results:

- case reports
- clinical trials
- comparative studies
- costing studies
- descriptive studies
- evaluation studies
- meta-analyses
- program evaluations
- qualitative studies
- randomized controlled trials
- systematic reviews
- validation studies

Studies excluded from preliminary database search results:

- editorials
- letters
- think pieces
- general/non-academic overviews

B. Hand searches

Appendix B (p. 12) contains a list of key journals in the field of telehealth and relevant conference proceedings that were hand-searched. Up to five years of back issues were searched.

C. Internet searches

Key organization and government web sites were searched as listed in Appendix B, pp. 13-14. Free text Internet searches were also undertaken, using the Google and Copernic search engines along with the main search terms listed in Appendix B, p. 1.

D. Reference lists

Reference lists of key journal articles were scanned to identify further studies of interest.

E. Consultation with investigators

Team investigators were able to identify, through previous research and consultation with colleagues, additional articles and reports relevant to the study.

F. Refinements on Initial Database Search Results

From the initial search results and information gleaned from government reports on identified health care priorities in Alberta and Canada, it was decided to focus on these aspects of telehealth:

1. Children/Paediatrics
2. First Nations
3. Geriatrics (Homecare, Mental Health, Pharmacy)
4. Homecare
5. Mental Health
6. Radiology
7. Renal Dialysis
8. Rural & Remote
9. Rehabilitation
10. Ultrasound

Additional searching of existing results was done to locate subsets of the publications in these categories. Lists of search terms for each of the above categories are provided in Appendix B (pp. 8-11).

IV STATE OF THE SCIENCE REVIEW PROCESS

i. Abstract Review Process

Abstracts identified through the search strategy were entered in Reference Manager and were grouped into ten subject areas:

- Paediatric telehealth
- First Nations telehealth
- Geriatric telehealth
- Tele-homecare
- Tele-mental health
- Teleradiology
- Tele-ultrasound
- Renal Dialysis telehealth
- Rural & Remote telehealth
- Telerehabilitation

It was decided that the subject areas of teleradiology and tele-ultrasound would be combined (due to the relatively low number of tele-ultrasound studies), bringing the total number of subject areas to nine. From this point forward, reference to teleradiology incorporates tele-ultrasound.

Some abstracts fell into more than one category, for instance, articles pertaining to both First Nations and Rural & Remote telehealth. The abstracts were distributed amongst three study investigators. Investigators reviewed abstracts and designated each as 'in', 'out' or 'uncertain', based on the following considerations:

1. The study is actually about telehealth.
2. There is comparison of telehealth with non-telehealth.
3. The study includes consideration of at least one of the issues in the list outlined in the study proposal:

Social Determinants of Health	Socio-economic performance of a community
• poverty • social isolation • education • life stress • early life • access to transport • nutrition • access to health services and care	• economy • labour markets • innovation • environment • education • health

4. Abstracts which contained no details (might be title only), were included for selection if there was uncertainty about whether appropriate for the study.

Abstract citations designated as 'in' or 'uncertain' were returned to the main office where they were ordered, retrieved, and sent to the investigators. During this process, three additional areas for analysis were identified:

- Telehealth reviews
- Telehealth policy
- Economic analysis of telehealth

Responsibility for the reviews, policy and economic analyses was assigned to two other study investigators. Sources pertaining to these areas were identified by the first three investigators upon review of abstracts and were referred on through the main office to the other two investigators.

Table 1 outlines the investigator responsible for each identified subject area and for the policy and economic analyses, as well as the total number of abstracts reviewed.

Table 1 State of the Science Telehealth Subject areas, Policy and Economic Analysis

Categories: Subject areas 1 to 10, and Policy and Economic Analysis*	**Investigator Responsible**	**Number of abstracts located in the search**	**Final number of articles / sources included**
1. Paediatric telehealth	Dr. D. Hailey	577	24
2. First Nations telehealth	Dr. R. Thomas	43	8
3. Geriatric telehealth	Dr. R. Thomas	1106	53
4. Tele-homecare	Dr. R. Scott	479	63
5. Tele-mental health	Dr. D. Hailey	461	16
6. Teleradiology	Dr. D. Hailey	493	27
7. Renal dialysis telehealth	Dr. R. Scott	80	12
8. Rural & Remote telehealth	Dr. R. Scott	1051	35
9. Telerehabilitation	Dr. R. Thomas	117	23
10. Telehealth Reviews	C. Anderson	124	29
Telehealth Policy	C. Anderson	74	59
Economic Analysis of telehealth	Dr. A. Ohinmaa	41	41
Total		4646	306**

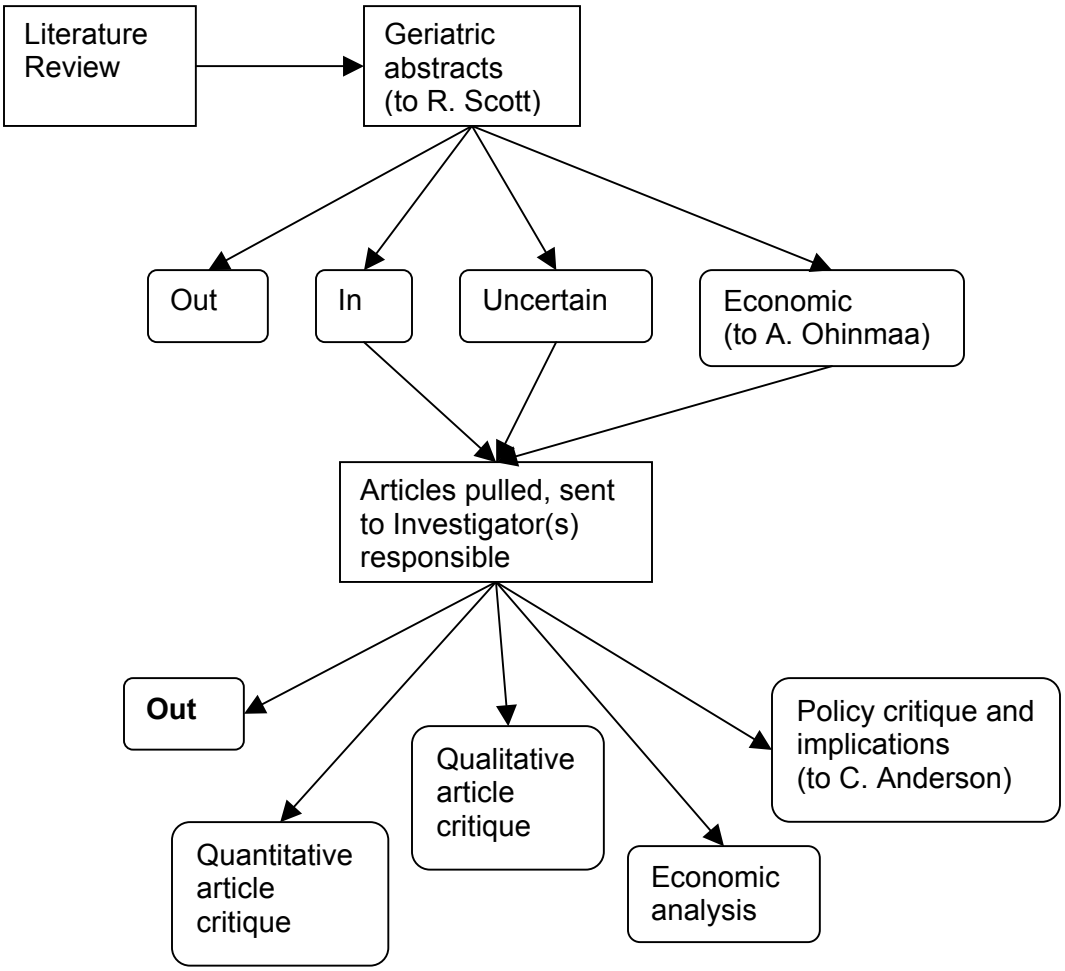
* These 12 categories are not mutually exclusive, i.e., one study could be counted in more than one category.

** The total number of sources included does not equal the sum from the twelve categories because some sources were assigned to and reviewed within more than one subject area.

The review process is illustrated with the example of geriatric telehealth in Diagram 1.

Diagram 1: Process for Abstract review and Critique

Example: Geriatric telehealth review



ii. Critique of Articles: Process

As investigators received the articles and sources that they had ordered, they classified these sources as quantitative or qualitative. If sources were economic- or policy-related, investigators referred these through the central office to the other investigators responsible for Economic Analysis and Policy.

Quantitative Research Critique

Quantitative articles were selected for inclusion in the final report if they contained Good to Fair evidence based on study design and research methodology as outlined in the 1995 Jovell/Navarro-Rubio scale (Hailey et al, 2002). Good to Fair evidence comprises categories I through VII in Table 2.

Table 2 Levels of scientific evidence

Level: highest (I) to lowest (IX)	Strength of evidence	Type of study design	Conditions of scientific rigour*
I	Good	Meta-analysis of randomized controlled trials	Analysis of individual patient data Meta-regression Different techniques of analysis Absence of heterogeneity Quality of the studies
II		Large-sample randomized controlled trials	Assessment of statistical power Multicentre trial Quality of the study
III	Good to fair	Small-sample randomized controlled trials	Assessment of statistical power Quality of the study
IV		Non-randomized controlled prospective trials	Concurrent controls Multicentre trial Quality of the study
V		Non-randomized controlled retrospective trials	Historical controls Quality of the study
VI	Fair	Cohort studies	Concurrent controls Multicentre study Quality of the study
VII		Case-control studies	Multicentre study Quality of the study
VIII	Poor	Non-controlled clinical series Descriptive studies: surveillance of disease, surveys, registers, databases, prevalence studies Expert committees, consensus conferences	Multicentre study
IX		Anecdotes or case reports	

* Quality of the study as assessed by specific protocols and conditions of scientific rigour.
Source: Derived from Jovell and Navarro-Rubio (1995)
(Hailey et al, 2002)

If a source did not contain good-fair evidence, it may still have been included in the final report for comment if it contained important information related to socio-economic determinants of health or socio-economic indicators. This determination was made based on the expert opinion of the study investigators.

Exclusions

a) Non-comparative studies with no reference to social determinants of health or socio-economic indicators
b) Studies that were concerned only with equipment or other technical evaluation
c) Studies where there was substantial doubt regarding scientific validity

All quantitative articles that were included were analyzed and the following data abstracted and charted (based on the Cochrane Collaboration Review Manager framework):

- Article / Title / Author / Year / Country / Location
- Purpose/ Objectives
- Design
- Analysis
- Participants: age / gender/ groups
- Intervention / Duration
- Follow-up: sample size; dropout
- Outcomes / Socio-Economic Indicators
- Methodological Problems
- Policy Recommendations
- Applicability to Alberta

Qualitative Research Critique

Qualitative research in the area of telehealth is valuable because it asks questions that quantitative research may or cannot answer, such as those related to readiness or processes. Qualitative methodologies have the ability to explain complex themes, and to allow consideration of a wide range of interrelationships among historical events and social structures over multiple domains (Trauth, 2001).

There were twelve qualitative articles found for the project. These articles were pulled from their respective topic areas and reviewed independently. The following data from each article was abstracted and charted (based on the Cochrane Collaboration Review Manager framework):

- Article / Title / Author / Year / Country / Location
- Purpose/ Objectives
- Design
- Analysis
- Participants: age / gender/ groups
- Intervention / Duration
- Follow-up: sample size; dropout
- Outcomes / Socio-Economic Indicators
- Methodological Problems
- Policy Recommendations
- Applicability to Alberta

The analysis of the selected qualitative studies can be found in Appendix Q – Critique Qualitative.

The criteria used by the reviewers to rate the quality of the articles were:

1. *Dependability:* The question of sampling is paramount. Did the sample include the full range of possible cases or settings so that conceptual rather than statistical generalizations can be made? A sample size of 30 or greater is recommended in order to generate a full rage of cases (Stebbins, 2001).
2. *Credibility:* Did the researchers acknowledge the issue of validity, and if so, how was it dealt with? Triangulation of method, where more than one kind of data source is looked at, is one way of addressing concerns of validity.
3. *Transferability:* This concept deals with theory development, and whether the knowledge can be transferred to others. Were the research questions clearly set out, and did the conclusions address those questions?

Based on the above criteria, five articles were rated as good in quality (Campbell et al, 2001; Carroll et al, 2001; Franken et al, 1996; Monrad Aas , 2002; Whitten et al, 2001), one was rated as fair (Gallienne et al, 1993), and the final five articles were rated as poor (Dansky et al, 1999; Hanson, 2000; Magnusson et al, 1997; Tually et al, 2001; Whitten et al, 1997).

Economic Analysis Critique

The Drummond et al (1997) criteria were used to critique economic analyses. These criteria consist of the following considerations:

1. Was a well-defined question posed in answerable form?
2. Was a comprehensive description of the competing alternatives given?
3. Was the effectiveness of the programs or services established?
4. Were all the important and relevant costs and consequences for each of the alternatives identified?
5. Were costs and consequences measured accurately in appropriate physical units?
6. Were costs and consequences valued credibly?
7. Were costs and consequences adjusted for different timing?
8. Was an incremental analysis of the costs and consequences of the alternatives performed?
9. Was allowance made for uncertainty in the estimates of costs and consequences?
10. Did the presentation and discussion of the study results include all issues of concern to users?

iii. Strengths and Limitations of this Study

The primary strength of the study was the varied and extensive expertise and experience of the project team, which consisted of the principal investigator and five other investigators, a research librarian, a local policy team of eight telehealth, information and communications technology (ICT), public health, and epidemiology researchers, policy leaders and strategists; as well as project managers and assistants. The list of project team members, their titles and qualifications, can be found in Appendix A: Project Team Members, Advisors and Assistants.

Midway through the project (Summer, 2002), a Policy Working Group, consisting of federal/provincial/territorial policy- and decision-makers, was identified through key contact referrals. This group was made aware of the study, its purpose and objectives, and many of these individuals provided valuable contributions in terms of policy implications and interpretation, and development of the results framework.

A comprehensive and exhaustive literature search enabled the team to identify a consummate body of literature related to the two key subjects of the study: 1) telehealth and 2) Social Determinants of Health / socio-economic indicators. Clearly outlined research questions and review processes enabled the effective progression of the study.

There are three limitations to this study which should be mentioned. Firstly, State of the Science Program limitations precluded the ability to have two reviewers assess each paper in this study. Once abstracts were grouped by subject area (i.e., Paediatrics, telerehabilitation, etc.), the subject areas were divided amongst five investigators and the task of selecting and reviewing articles relied upon the individual expertise and experience of one of five investigators. To mitigate any potential differences in selection and review processes, criteria were developed and the team met regularly to review progress and to discuss and resolve particular issues or concerns.

The second limitation of the study is that systematic reviews could not be assessed for strength of evidence as no rating system was available. The search strategy for telehealth review sources identified both systematic reviews and literature reviews, which are differentiated within the reviews analysis. A paper can be called a systematic review if it satisfies certain criteria, such as clear research question and associated transparent search strategy, and inclusion/exclusion criteria.

The subject areas identified for this study represent promising areas for telehealth application based on current health needs and initiatives and recognized health system priorities. Evidence pertaining to each subject area and ensuing recommendations cannot be generalized across subject areas or to the population as a whole, which may be seen as a limitation. For instance, evidence and recommendations related to a medical condition in Geriatrics cannot be applied to the same medical condition in adults. Wherever evidence or recommendations have been provided which relate to a particular population group, this has been specified.

V STATE OF THE SCIENCE RESULTS

Chapter 1: Paediatric Telehealth

Highlights

- Telehealth is shown to improve quality of care for adolescents with asthma. Telephone reminder messages improved quality of care with respect to immunization.
- For neonatal intensive care, evidence was found for improved efficiency, quality, and possible stress reduction through use of telehealth. There is an economic benefit in avoiding transfers of neonates to specialist centres.
- Telehealth can achieve time savings for staff and in data transfer.
- A study of social environment described how an interactive computer network decreased feeling of loneliness for sick children.
- Cost savings can be achieved for Paediatric consultations via telehealth.

Statistics on the literature

From the literature, 11 abstracts were identified that appeared to describe randomized controlled trials (RCTs) in Paediatrics, all of which were selected for further review. Of these 5 were subsequently excluded (one very small RCT which was no more than a feasibility study, an abstract with insufficient details, a study that used non-comparative self-reported outcomes and two studies on high risk pregnancy populations). Six studies were selected and data abstracted; five of these were RCTs and one a Delphi study.

A total of 142 abstracts related to non-randomized studies were identified of which 76 were selected for further review. Of 71 papers reviewed, 18 were selected for analysis and 55 were rejected (two of these duplicates in the data base). Brief reference is made to seven of the rejected studies, which contained material that is worth considering in reviewing the place of telemedicine in Paediatrics.

Refer to Appendix E – Critique Paediatrics for analysis of the 24 included studies.

Location of Study and Areas of Application

Nineteen of the 24 studies were from the USA, there were two from Canada and one each from Greece, Iceland and the UK.

The general areas covered by the selected studies are shown in Table 1.1. Studies dealing with cardiology applications were the most common, and included five from the same research group in North Carolina. Three of those studies also specifically relate to neonatal intensive care (NICU).

Table 1. 1 Areas of study for Paediatric applications

Area of study	RCTs	Non-RCTs
Management of asthma	1	
Immunisation rates	2	
NICU	1	
Emergency room		2
Difficult infants/ maternal distress	1	
Cardiology		13
Social environment for sick children		1
After hours referral triage		2
General consultations		1
School-Based		1

Paediatric Telehealth Applications and Social Determinants of Health

Indications from the papers that were analyzed are summarized below. Results from both RCTs and non-randomized studies are discussed.

Management of asthma

Bynum et al (2001) provide reasonable evidence of improved quality of health care in a rural adolescent population through provision of telepharmacy counselling (instruction & demonstration) using interactive compressed video.

Immunisation rates

There is good evidence that telephone reminder messages increased quality of care and access to appropriate intervention in a rural US population; apparently also good support for such an approach in a Health Maintenance Organization (HMO) population, but some details of the study are not available (Lieu et al, 1998; Dini et al, 1995).

Neonatal intensive care

Utilization of the internet and videoconferencing to provide distance learning and "virtual visits" resulted in enhanced medical, informational, and emotional support, and increased quality of care and satisfaction, for families of very low birth weight infants (Gray et al, 2000). Cost data were not provided.

Emergency room

A telephone triage system for screening referrals to a US hospital attempted to improve quality and efficiency of health care, but the evidence is relatively poor (Barber et al, 2000 – Delphi study). An observational study by Kallis et al (1999) suggests a POTS (plain old telephone service) approach to assigning primary care providers to Emergency Department patients.

These studies do not convincingly demonstrate effects on social determinants of health in this area of Paediatric management.

Difficult infants

Thome and Alder (1999) provide good evidence that telephone-based intervention reduced maternal fatigue but not parental stress.

Cardiology

Twelve non-randomized studies deal with the use of Paediatric tele-echocardiography and provide evidence of benefits from this type of application. This is consistent with the conclusions of an earlier systematic review (Ohinmaa et al., 1999) which identified transmission of echocardiographic images as one of the telehealth areas for which there was some convincing evidence of effectiveness. Five of the studies are from a group in North Carolina, USA.

Five of the studies, from different centres, draw attention to benefits through avoiding transfer of neonates to specialist centres. The North Carolina group found a 58% reduction in such transfers following the introduction of tele-echocardiography (Rendina et al, 2001). The other studies (Mulholland et al, 1999; Sable et al, 1999; Finley et al, 1997; Tsilimigaki et al, 2001) provide some indication of transfers avoided and related cost benefits, though there is no rigorous analysis. The paper by Tsilimigaki et al (2001) notes the social benefits from a tele-echocardiography service for a community that is remote from specialist services.

A related paper by Sable et al (2002) found evidence of time savings for staff and Mehta et al (2001) demonstrated time savings in transfer of data and consequent action, as compared with courier services.

Three of the studies by Rendina et al (1997, 1998, 2001) examine the association between introduction of tele-echocardiography and length of stay (LOS) in neonatal intensive care. There was an indication of a reduction in LOS (not statistically significant) for a small group of neonates and stronger evidence of a reduction in stay for very low birth weight infants. A further study found no evidence of telemedicine having an effect on utilization of respiratory therapy. The study by Scholz et al (1999) on ordering patterns suggested higher use of echocardiographic tests by community physicians than by cardiologists, perhaps suggesting the potential for inappropriate use.

The remaining cardiology paper dealt with monitoring of Paediatric patients who had received a pacemaker, but does no more than indicate feasibility (Vincent et al, 1997).

Social environment for sick children

The paper by Battles et al (2002) describes the use of an interactive computer network by children with life threatening diseases who were being treated by a major hospital. Children and their parents reported reduced feelings of loneliness and greater willingness to return to hospital for further treatment.

After hours referral triage

Two studies dealt with use of POTS-based systems to triage requests for advice and services and showed decreased rates of referral without adverse effects (Kempe et al, 2000; McLario et al, 1998).

General consultations

A paper by Dick et al (1999) gave indications of cost savings to families through use of videoconferencing technology for Paediatric consultations.

School-Based

A qualitative paper by Whitten et al (2001) describes the use of telemedicine in schools. The perception of nurses identified more problems than benefits, but most responses centered on positive, rather than negative aspects of the project. For instance, school administrators felt that an important aspect of the project was that the children saw a physician.

General areas of benefit for which there was reasonably convincing evidence are summarized in Table 1.2. There was one example of a potential reduction in efficiency of services and one where there was no effect on stress.

Table 1.2 Areas of benefits from Paediatric studies

Area	Number of studies*
Quality of health	1
Quality of care	3
Reduction in transfer of patients	5
Efficiency of services	5
Reduction in hospital LOS	3
Reduction in stress or fatigue	3
Reduction in feelings of loneliness	1
Reduced travel cost for families	1

* Some studies considered more than one of these areas

Comment on selected non-comparative studies

Seven studies were located that appeared to provide useful descriptions of telehealth programs in Paediatric applications, while not having sufficient comparative information for analysis. In some of these, successful changes from baseline health measurements were demonstrated through implementation of a telemedicine program but there was no adequate comparison with a non-telehealth alternative. The topics covered in these studies were management of asthma, school-based telehealth, management of diabetes, special health care needs, speech therapy and surgery consultations. They suggest further areas of benefit in Paediatric applications of telemedicine.

Applicability to Alberta

A number of studies provide evidence of the socio-economic benefit of telehealth in Paediatric populations. These findings are significant as the health and health care of the Paediatric population are high priorities for the province. Applications which are relevant to the Alberta setting include:

Video-based technology

- Videoconferencing to remote communities for provision of specialist services (Dick et al, 1999). This type of service would be applicable and could be cost-saving in some Alberta communities.

- Tele-echocardiography has demonstrated the following benefits:
  - Improved patient care & management / timeliness of diagnosis and treatment (Mehta et al, 2001; Rendina et al, 1998, Sable et al, 1999; Sable et al, 2002),
  - Reduced rate of patient transfer (Rendina et al, 2001; Sable et al, 1999),
  - Reduced length of stay in intensive care (Rendina et al, 1998)
  - Cost-effectiveness (Mulholland et al, 1999; Finlay et al, 1997; Sable et al, 1999; Tsilimigaki et al, 2001).

  This service is applicable in the Alberta setting but would require local validation of expected benefits (e.g., cost effectiveness from a health system or societal viewpoint, resource utilization).

- Telepharmacy counselling (education & demonstration) for adolescents with asthma, using interactive compressed video (Bynum et al, 2001).

- Internet and videoconferencing technology for distance learning and "virtual visits" (Gray et al, 2000).

Computer-based technology

- Interactive computer network for health education and communication (Battles et al, 2002)

Telephone-based applications

- Computer-generated telephone reminder calls (Dini et al, 1995; Lieu et al, 1998)

- Telephone counselling for new mothers (Thome & Alder, 1999)

- Telephone triage services for after-hours referrals (Kempe et al, 2000); for calls related to fever in young children (McLario et al, 1998).

Summary of Economic Analysis for Paediatrics

(For full details refer to Chapter 11: Economic Analysis.)

The economics of Paediatric telehealth applications was analyzed mainly from a health care provider or patient/parental perspective. From the health care perspective, the cardiologic consultations seem to be cost saving (at least after certain workload), partly because the investment cost to the system is not high, and the costs of transporting and caring for neonates in intensive care units are very high. From the patients/parents perspective, Paediatric specialist and Paediatric congenital heart disease consultations can be cost-saving for patients' families.

The quality of the economic studies was poor, since the studies fulfilled only 0 to 3 quality criteria. This means that although the results can give some initial information about the magnitude of the costs and possible cost savings, the results cannot be fully used in actual decision-making due to the likely bias of results in both directions.

Chapter 2: Geriatric Telehealth

Highlights

- The telephone can be used for patient assessment, monitoring (with decision support), education, reminder calls, or treatment. Benefits include reduced hospitalization rates, improved patient satisfaction with care, increased medication and exercise compliance, and improved patient outcomes (e.g., depression, hypertension).
- Personal alert systems can result in reduced rates of hospitalization.
- Support for caregivers can be provided by an electronic network with information, decision support and communication capacities.
- There are many identified potential benefits of video consultation, including access, patient satisfaction and cost savings.
- Telehealth can enhance quality of life for elderly people and people with mobility problems (especially those living alone) by providing an increased ability to live independently and increased sense of security.
- Education can be provided via telehealth; for instance, regarding medication interactions. Demonstrated results include increased patient self-efficacy with respect to medication use, and reduced adverse effects.

Statistics on the literature

A total of 1106 articles and other sources which appeared to be related to geriatric telehealth were identified in the literature search. Upon review of abstracts, 79 articles were selected for further review. Twenty-six were subsequently excluded for the following reasons:

(a) the articles did not pertain to telehealth or
(b) the articles were descriptive and related to telehealth but contained no scientific evidence and no reference to socio-economic issues or indicators.

The 53 articles selected for analysis included 14 RCTs and 39 non-RCTs. Three of the RCTs were considered to provide poor scientific evidence based on study design and methodology. Five of the non-RCTs were well-designed comparative studies (e.g., non-randomized controlled trials, cohort studies, case control studies) and are included with 11 RCTs in the section describing good-fair scientific evidence (total 16 studies). There were a total of 37 non-comparative studies included for comment regarding socio-economic indicators.

Full analysis of the 53 included studies can be found in Appendix F – Critique Geriatrics.

Areas of application and Location of studies

The areas of study of the 16 Geriatrics telehealth applications providing good to fair scientific evidence are listed in Table 2.1, and the origins of studies are given in Table 2.2. Most (75%) of the studies were American.

Table 2. 1 Areas of study for Geriatrics telehealth applications

Area of study	RCTs	Non-RCTs
Chronic heart failure / cardiac	3	
Hypertension	2	
Oncology		1
Mental health	1	1
Persons with disabilities		1
Home support, incl. Emergency response	3	1
Medications	2	
Information		1

Table 2.2 Origin of Geriatrics telehealth studies

Country	Number of studies
USA	12
UK	2
Canada	1
Spain	1

Geriatric Telehealth Applications and Social Determinants of Health

Table 2.3 lists the general areas of benefit of telehealth that are supported by Good to Fair scientific evidence.

Table 2.3 Areas of benefit from Geriatrics telehealth studies

Area	Number of studies*
Access	8
Cost / Cost-effectiveness / health system utilization	6
Education	3
Support	4
Acceptability / client satisfaction	6
Health outcomes	3
Quality of care	2

* Some studies considered more than one of these areas

Thirteen of the 16 studies involved telephone-based applications such as telephone support, reminders or assessment, or in the case of the emergency response system, use of telephone lines to transmit emergency signals. Two of the thirteen telephone-based projects also involved videoconference / videophone technology, but in these studies, the addition of the video component did not provide benefits over and above the benefits realized from the telephone component.

Cardiac

There is good evidence that for elderly patients with chronic heart failure, telephonic case-management supplemented by decision support software can reduce hospitalization rates, increase patient satisfaction with care, and enhance cost-effectiveness (Riegel et al, 2002). There is good-fair evidence of compliance in telemonitoring for chronic heart failure patients (de Lusignan et al, 2001).

Anderson et al (1989) demonstrated that telephone monitoring is an effective method of supervising the care of patients with paroxysmal atrial fibrillation (the average age of patients in this study was 57, so results are not specific to Geriatrics).

Hypertension

Friedman et al (1996) provide good evidence that weekly use of an interactive computer-based telecommunications system as a supplement to physician visits for hypertensive patients improved medication adherence and blood pressure control and was cost-effective, particularly for patients who were initially non-adherent in their medication use.

A UK randomized controlled trial attempted to manage the care of geriatric hypertensive patients utilizing a computer decision support system and cardiovascular risk chart; however, there was no evidence of benefit in terms of cardiovascular risk (Montgomery et al, 2000)

Oncology

There is good-fair evidence (Subirana Serrate et al, 2001) that oncology patients can be cared for at home and avoid hospitalization if provided with 24-hour telephone support from a doctor and home visits by a specialized nurse team dispensing specific treatments (e.g., chemotherapy, parenteral feeding, intravenous therapy, blood transfusions, pain treatment and functional rehabilitation). This program has implications for costs and on independent living for patients.

Mental Health

A study by Hunkeler et al (2000), provided good evidence that nurse telehealth care resulted in reduced symptoms, improved functioning, and greater satisfaction with care for depression; however, the program did not improve medication adherence.

The Structured Telephone Interview for Dementia Assessment (STIDA) and its short form were shown to be efficacious tools for detecting dementia and may have utility for initiating early intervention for AD (Go et al, 1997).

Persons with disabilities

In a case-control study where an automated telephone monitoring system was used to assess changes in functional status in community-residing disabled elderly persons, it was found that the in-person method captured more information (Mahoney et al, 1999). However, the telephone system was proven to be reliable and may be useful as a means to target individuals for further professional assessment. The authors note the importance of identifying and responding to clients' perceived needs (i.e., listening for client-identified needs rather than relying solely on needs as indicated by the results of the assessment tool).

Home support

There is fair evidence from a cohort study evaluating the Lifeline Program, which uses telephone lines to provide emergency response for community-residing elderly people, shows that the technology can reduce inpatient utilization (Roush and Teasdale, 1997). The program did not have a statistically significant effect on Emergency Department visits. This intervention also has implications for enhanced feelings of security, self-efficacy and independent living.

In a randomized controlled trial in Quebec, Infante-Rivard et al (1988) did not find a significantly significant difference in ambulatory encounters in a home telephone support program.

Wasson et al (1992) demonstrated that a Veterans population experienced reduced inpatient and outpatient health system utilization and reduced costs due to a physician telephone care program. The authors state that the program was particularly cost-effective for men who had reported fair or poor overall health at baseline. Welch et al (2000) tried to replicate the Wasson study in Veterans Clinics in Colorado and South Dakota, but their intervention did not show any effect on utilization or health status.

There was fair evidence from a qualitative study (Brennan et al, 1994; Galienne et al, 1993) that an electronic network proving information, peer communication, and access to a professional, to caregivers of persons with Alzheimer's Disease was successful in supporting the caregivers. This has implications for quality of care, independence and quality of life, as well as social support.

Medications

In a RCT in New York, Fulmer et al (1999) found that telephone and video-phone calls increased compliance with medication regimes. There was no added benefit of the video-phone over the telephone.

Neafsey et al (2000) used an interactive multimedia computer software program to test its effectiveness on adults' knowledge of potential interactions of prescription medications with over-the-counter drugs and alcohol, to increase self-efficacy (i.e., feelings of confidence regarding self-care) and avoidance of such interactions. The experimental group showed improvements in knowledge and self-efficacy.

Information
A computer-based medical decision-support system (MDSS) was not effective in assessing the accuracy of medication recording in the electronic medical records (Wagner and Hogan, 1996).

In a UK cluster randomized controlled trial (RCT), Montgomery et al (2000) were unable to show that hypertensive patients managed either by a computer decision support system and a cardiovascular risk chart

Demostrated benefits of telephone-based applications

Many of the studies described above demonstrated benefit for telephone support and assessment. This evidence is summarized here:

- Decreased utilization of health services (Riegel et al, 2002; Subirana Serrate et al, 2001; Wasson et al, 1992; Roush & Teasdale, 1997)
- Decreased cost / cost-effectiveness (Riegel et al, 2002; Subirana Serrate et al, 2001, Friedman et al, 1996; Wasson et al, 1992; Roush & Teasdale, 1997)
- Improved clinical outcomes (Hunkeler et al, 2000; Friedman et al, 1996; Wasson et al, 1992)
- Equivalent or increased patient satisfaction with care (Riegel et al, 2002; Hunkeler et al, 2000; Wasson et al, 1992)
- Improved medication adherence (Fulmer et al, 1999; Friedman et al, 1996)
- Efficacy in screening / assessment (Mahoney et al, 1999; Go et al, 1997)
- Information transfer: patient to provider (de Lusignan et al, 2001)

Comment on Non-Comparative Studies

There were a number of descriptive studies that introduced innovative approaches in Geriatric telehealth, with socio-economic implications.

Other suggested benefits of telephone-based applications

- Enhanced quality of care: increased frequency of clinician contact can lead to more timely, appropriate treatment (Subirana Serrate et al, 2001)
- Decreased waiting and travel time for patients (Wasson et al, 1992)
- Increased sense of security; increased ability for elderly people to live independently (Roush & Teasdale, 1997; Infante-Rivard et al, 1988)
- Enhanced social/emotional support (De Leo et al, 1995); coping skills (Strawn et al, 1998)
- Enhanced self-care / health promotion (Castro et al, 2001)
- Increased family cooperation and reduced level of stress experienced by relatives (Subirana Serrate et al, 2001)
- Improved client satisfaction, possible cost-effectiveness (i.e., telephone assessment; McGrew and Quinn, 1997)
- Reduced costs and hospitalization (LifeMasters, 2001)

Socio-economic indicators:

Life Stress

- Markson et al (1992) refer to reduction in life stress for patients in relation to a computer check-up service.
- Berkman et al (1999) discuss telephone support for elderly persons in Israel during a time of crisis: the Gulf War of 1991.

Quality of Care

- Magnusson et al (1997) examined quality of care in terms of improving caregivers' ability to provide care for elderly persons.
- A fall prediction system in elderly peoples' homes may prevent falls (Cameron et al, 1997) or warn professionals regarding a change in patient behaviour while the patient is in the home (Chan et al, 1998). These initiatives indicate the potential of artificial intelligence to increase quality of care, and also relate to the socio-economic indicator, innovation.
- Tang et al (2000) suggested that continuity of care can be enhanced through video-consultation (i.e., coordination of physician activities)

Quality of Life

- Magnusson et al (1997) suggest the possibility of the ACTION (assisting carers using telematics interventions to meet older person's needs) system to maintain or enhance the quality of life of older disabled persons and caregivers.

Social Isolation and Support, Independence and Self-care

- Family caregivers of elderly persons can be provided with support through computer systems which allow for direct access to care information and practical advice. This service can improve caregivers' competence and ability to provide care and may alleviate problems associated with social isolation (Magnusson et al, 1997).
- A descriptive article by Markson et al (1992) reviewed a pilot project which suggested that using computers as clinician extenders made patients feel more secure or less worried about their illness, and made them feel like active participants in their own medical care. These factors could have a positive impact on elderly persons' independence.
- Castro et al (2001) examined a home-based exercise program supported by telephone counselling. This intervention relates to health promotion, and specifically, support for improved self-care practices.

Patient Satisfaction and Perception

- A descriptive study by Macduff et al (2001) addressed issues of users' perceptions telehealth and patient satisfaction.
- Stiles et al's (1998) pilot study noted that both participants and consultants reported an overall positive experience with the use of a nutrition telemedicine consultation.
- Patients and families reported satisfaction with video consultation in a geriatric mental health program (Johnston & Jones, 2001).

Access

- Tele-mental health can be used to deliver services to rural populations that may not otherwise receive services; and video consultation can facilitate emergency consultations (Tang et al, 2001).
- Macduff et al (2001) address the convenience to patients of using telemedicine.
- Scalvini et al (1999) examine the initiative of enhanced professional support to rural physicians. Improved access to speciality consultation relates to the socio-economic viability of rural communities, in terms of retaining skilled professionals.
- An interactive satellite teleconference enabled patient and provider access to tele-learning (Coogle et al, 1995).

Geriatric Mental health applications

Access to information

In the area of geriatric mental health, a number of initiatives have been described that relate to patient tele-assessment and increasing providers' access to information. This could impact on timeliness and quality of care.

- Elderly patients in the waiting rooms of two general practices in Brisbane, Australia, were provided with a computer-based screening instrument containing a questionnaire designed to diagnose depression (Hegarty et al, 1996).
- Telephone administration of the SF-36 (Weinberger et al, 1994)
- Ames (1992) tested the 4-year predictive validity of a computerized diagnostic program to derive psychiatric diagnoses for elderly persons with depression.

Cost

It has been suggested that video consultations in geriatric mental health can

- decrease hospitalization rates (Lyketsos et al, 2001),
- save travel time and cost for patients (Johnston & Jones, 2001),
- save travel time and costs for care providers as compared with on-site visits, and be cost-effective in some settings (Tang et al, 2001).

An important concern raised by Montani et al (1997), as well as Jones et al (2001), is that there can be limitations in video consultation programs due in part to technology. In the absence of federal regulations regarding video technology and clinical accuracy, professional organizations need to set clinical standards for telemedicine in special populations such as geriatric psychiatry (Jones et al, 2001).

Applicability to Alberta

A limited number of psychometric tests have been validated for use via telehealth (phone and videoconferencing). The short form of the STIDA is potentially useful tool for the provincial mental health help line, which is slated for integration with the Health Link service (Go et al, 1997).

Hunkeler et al (2000) present an augmentation to physician care for depression. The challenge is who would be responsible for delivery of the nurse telecare. Care of geriatric psychiatric patients in the community often falls to home care although other

parties include mental health clinic staff, community geographic or outreach teams (e.g., Central Alberta Psychogeriatric Community Outreach Service). Divestiture of Alberta Mental Health Board (AMHB) clinics to the health authorities may help in coordinating opportunities for this kind of intervention.

Fulmer et al (1999) found that telephone and videophone both showed increased medications compliance regarding chronic heart failure and this speaks to the merit of Alberta telehealth business cases including consideration of the simplest/ most cost-effective technology. Some already are doing this. For example, the Capital Health Authority Telehealth Business Plan template includes analysis of alternate approaches.

In Alberta, tele-homecare has not yet been widely adopted. The study done by de Lusignan et al (2001) contributes to the evidence supporting telehomecare. Northwestern Health Services Region has recently purchased equipment for this purpose. There are presently outstanding questions with need for development of technical standards for this application.

Subirana Serrate et al (2001) discuss alternate care of oncology. The Mazankowski report encourages alternate models of care. It is interesting to note that one support to a service of this kind in Alberta could be the Link Service, which is rolling out provincially and is including new services/ innovations.

Friedman et al (1996) have an interesting approach in their article on automated telephone monitoring of hypertensive patients which could be compromised by existing Fee for Service Billing plan - probably most applicable to physicians compensated under alternate payment plans.

Summary of Economic Studies

(For full details refer to Chapter 11: Economic Analysis.)

The geriatric studies employed mainly a health care perspective in the economic analysis. The quality of the few studies found in the field was weak to moderate. The results show that the telephone can be a cost saving method of providing medical advice to geriatric patients due to reduced use of hospital /nursing home services. In the long-term care setting the utilization of videoconferencing for chronic wound consultations was also seen as cost-saving since both the transportation of chronically sick geriatric patients and visiting of specialists at long-term facilities are relatively expensive alternatives to videoconferencing. Because the evidence is based on relatively few economic studies with low or moderate quality, these results can be considered to be tentative. There is a need for more studies to confirm these results, e.g., in Alberta.

Chapter 3: First Nations Telehealth

Highlights

- Interactive computer programs are an effective means of providing education and assessing behavioural risk. It is important that information be delivered in a culturally sensitive context.

- A 3-year federal Health Transition Funds project, consisting of telehealth initiatives in five First Nations communities across Canada, delivered the following policy recommendations:
    - Increase connectivity to rural and remote communities, and especially Aboriginal communities;
    - Undertake new research further to implementation of successful telehealth initiatives in First Nations and Inuit communities, and regarding the impact of telehealth on costs, health services and human resources;
    - Promote equality of opportunity for telehealth across First Nations and Inuit communities;
    - Increase awareness and understanding of telehealth opportunities among First Nations and Inuit stakeholders;
    - Create linkages between telehealth and other initiatives of the Aboriginal Health Infostructure in order to leverage investments.

  (Health Canada, 2001)

- Telehealth can improve access to services for remote First Nations communities.

- The ability to access mental health services in the local community via telehealth may represent a significant quality of life benefit.

Statistics on the literature

The literature search identified 4 Randomized Controlled Trials (RCTs) and 39 non-RCTs related to First Nations. One of the RCTs and 7 of the non-RCTs were identified as pertaining to telehealth and having socio-economic implications. These eight sources are described here. Data from these sources were abstracted and can be found in Appendix G – Critique First Nations.

Location of Studies and Areas of Application

Only two comparative studies were found in the literature search: one RCT (Schinke et al, 1994) and one cohort study (Lapham et al, 1993). Both were US studies and both had patient education components. Six other non-comparative studies were included, as some

of them contain valuable recommendations and/or insights regarding the benefit of telehealth for First Nations. Four of the six described Canadian projects; one was from the US and one from Australia.

First Nations Telehealth and Social Determinants of Health

Education

A study by Schinke et al (1994) involving 368 Native American youths, aged 10-14, in the South-eastern US, sought to test an effective way of reducing cancer risks and improving dietary choices. The study randomized participants into an intervention group where they completed an interactive computerized lesson using Native American legends to provide information about cancer reduction through diet and not smoking. Participants in the control arm did not receive the software intervention. Those in the intervention group increased their scores on 8 of 12 knowledge items. The importance of presenting material within a culturally-sensitive context was emphasized.

Computer assessment

In a study by Lapham et al (1993), Native American women receiving prenatal care at two clinics in New Mexico were contacted and, if eligible, were asked to complete the Pregnancy Information Program, an interactive computer program designed to assess behavioural risks and provide health education for pregnant women. A total of 265 women were enrolled over 13 months. More than 95% of participants who completed the computer interview rated it favourably and the majority of women reported learning new information through the program.

Drug use and physical abuse were reported significantly more often during the computer interview compared with the information obtained from the patients' medical records. The accuracy of self-reporting regarding recent drug use was validated in the results of urine drug screens.

The study findings cannot be generalized to all Native American women as the participants in the study were primarily urban. However, the authors conclude that computerized assessment is well-received by patients and yields valid information regarding risk factors for adverse pregnancy outcomes.

Comment on non-comparative sources

Although the following projects do not provide any scientific evidence of effectiveness of telehealth as compared to traditional health care delivery methods, they do suggest important socio-economic considerations, many of which are unique to Aboriginal populations, as well as policy recommendations.

Canadian projects

The federal Health Transition Funds project (1998-2001) consisted of telehealth initiatives in 5 First Nations communities across Canada (Health Canada, 2001). Evaluation outcomes of the projects included:

- Response to community health needs;
- Acceptability of telehealth by patients and families, and satisfaction with quality of care;
- Improved access to needed, quality care;
- Development of professional skills and competencies of local staff through telehealth training, improved access to outside expertise and associated increased confidence in care and skills;
- Indications of decreased efficiency (e.g., related to increased appointment length in telehealth consultations and no-shows);
- Increase in cost of care due to improved access to care, but cost savings associated with patient transfers avoided;
- High level of integration and sustainability evidenced in some applications (real-time technologies are advantaged over store-and-forward systems);
- Linkage with other provincial telehealth systems;
- Increased awareness and knowledge of local conditions/ resources among health service providers.

The report also provides specific outcomes for each of the five community projects.

Critical success factors are identified for telehealth implementation in First Nations and Inuit communities. These factors relate to community, funding, management, health care/educational practice, technology and policy.

Overall recommendations of the project include:

- Increase connectivity to rural and remote communities, and especially Aboriginal communities;
- Undertake new research further to implementation of successful telehealth initiatives in First Nations and Inuit communities, and regarding the impact of telehealth on costs, health services and human resources;
- Promote equality of opportunity for telehealth programs and research across First Nations and Inuit communities;
- Increase awareness and understanding of telehealth opportunities among First Nations and Inuit stakeholders;
- Create linkages between telehealth and other initiatives of the Aboriginal Health Infostructure in order to leverage investments.

(Health Canada, 2001)

O'Neill et al (2000) describe a telehealth demonstration project serving a geographically large, culturally diverse (45% Aboriginal population) and sparsely populated area of northern Alberta. The purpose of the project was to facilitate enhanced primary health services, and the telehealth system was used for meetings, educational sessions (staff in-services), clinical consultations, and tele-ultrasound. A total of 42 telehealth sessions were conducted in 17 months. Observations and recommendations emphasize the importance of:

- initial needs assessment regarding telehealth applications,
- organizational preparedness with respect to technology and human factors (i.e., stakeholder support and user buy-in),
- user training,
- improved telecommunications to northern and rural communities,

- giving consideration to option of leasing equipment.

The Baffin Island Telemedicine Project, which involves videoconferencing, digital imaging and medical diagnostic services to support remote community Health Centres, aims to improve the quality of health care as well as quality of life for patients in isolated communities (Otto, 1999).

Information systems (Canada)
To facilitate the evaluation of intervention programs, the Medical Services Branch of Health Canada is providing an epidemiological database to the 126 First Nations Communities in Ontario listing data on:

- antibiotic resistance;
- clients with recurrent diseases, incomplete TB treatment, with Mantoux tests >=10mm, with a previous history of TB, a follow-up schedule for STD's, with a consultant's review pending, client follow-up plan, schedule and encounter summary;
- disease incidence and prevalence;
- a suicide registry; and
- an immunization register (Johnson, 1998).

This initiative has implications for health services planning and improved access to health services.

Teleradiology (US)
Beck et al (1996) indicate the following advantages of a teleradiology system established to support a regional hospital in Alaska:

- Clinicians from the regional hospital reported increased satisfaction with the improved level of support, particularly regarding emergency case management;
- Specialists reported satisfaction derived from increased confidence in accuracy of diagnosis;
- Economic: potential savings due to patient transfer costs avoided.

Tele-mental health (Australia)
Lessing and Blignault (2001) received information on 23 out of 36 Australian telemedicine mental health programs through a postal survey. The authors cite the potential for telehealth to reduce inequities in health services access for rural and other specified populations (e.g., Aboriginals). They also emphasize the value of tele-mental health programs for Aboriginals, as transfer from their community to a regional centre for services can cause mental distress and feelings of alienation.

Applicability to Alberta

Although the number of published studies is limited, evidence and insights exist illustrating that a number of telehealth applications can assist First Nation's health and health care. These include e-health care applications (Schinke et al, 1994); health and educational computer interactive programs for patients and the public (Lapham et al, 1993); and epidemiological databases (Johnson, 1998).

As First Nation's telehealth applications continue to be initiated in Alberta, for example, in partnership with the Federal Health Transition Funds First Nation's three year project

(Health Canada, 2001), the CHIPP Diabetic Retinopathy project (http://www.hc-sc.gc.ca/ohih-bsi/about_apropos/chipp-ppics/proj/westnet_e.html), and various demonstration projects (O'Neill et al, 2000), implications arise for Alberta. In order to leverage optimal success, lessons learned and recommendations from other Canadian First Nation's telehealth projects require careful review and adaptation prior to the initiation of future related activities. Also, increasing the awareness and understanding of telehealth opportunities among First Nation's stakeholders could be undertaken. Further, it is important to begin new research in the areas of cost and health services/human resources impact. Finally, it is recommended that Alberta's attention be directed towards historical critical success factors – for example, culture, community, funding, management, usual healthcare/educational practice, technology, and policy.

Summary of Economic Analysis

(For full details refer to Chapter 11: Economic Analysis)

There are no economic studies of First Nations telehealth applications. Since many of these communities are rural and remote, the economic analysis in the Rural and Remote Telehealth chapter is most applicable to these patients. However, First Nations populations may have some specific socioeconomic, cultural and epidemiological characteristics that might also influence the economic analysis of telehealth in this patient population. More research in this area is urgently needed.

Chapter 4: Home Telehealth

Highlights

- Utility has been demonstrated for broad clinical uses in home telehealth (chronic heart failure, chronic obstructive pulmonary disease, oncology, diabetes, wound care, asthma, anxiety, and cardiovascular accident)
- Other than cost and quality of life, extremely few socio-economic indicators have been addressed
- A policy void has been identified
- Nurses can typically make at least twice the number of home telehealth visits than traditional on-site visits (e.g., 15 versus 6)
- The number of traditional homecare visits that can be performed using home telehealth varies from 12 - 46%, and needs clarification in Canada.

The use of telehealth to facilitate healthcare in the home setting has been referred to in Canada as 'tele-homecare'. The American Telemedicine Association (ATA) has concluded this term might be misleading since telehealth in this setting encompasses more than simply providing traditional homecare in a new manner. For this reason the term 'home telehealth' was recently adopted by the ATA. This term includes use of telehealth for all forms of residence, e.g. nursing homes, and not just those in their own home.

Home telehealth studies lack scientific evidence (e.g., non-RCTs), but the results of evaluations to date demonstrate that telehealth technology works for many clinical needs, typically has high levels of clinician and patient satisfaction, and in select settings provides savings without compromising quality. Caution is needed when considering cost; as noted elsewhere in this review valid economic analyses are sparse. Examination of the integration of home telehealth into the continuum of care has been overlooked.

Similar to other aspects of this review, no studies identified or defined specific socio-economic outcome indicators. Clinical outcomes were addressed, but very few studies examined the effectiveness of telehealth in improving health status or the outcomes of health care. Video, web-based, and telephone modalities were all used successfully in various settings.

Statistics on the Literature

The literature search identified a total of 479 abstracts related to tele-homecare. From these, 127 articles were selected for further review. The final set of articles included for analysis in tele-homecare consisted of 11 randomized controlled trials (RCTs) and 52 non-randomized studies. Reasons that the remaining 64 articles were rejected were that 1) the articles did not pertain to telehealth or 2) the articles did not contain any good to fair evidence for telehealth nor any reference to socio-economic indicators.

Analysis of the selected RCTs and non-randomized studies is given in Appendix H: Critique Tele-homecare.

Areas of application

The general areas covered by the selected studies are shown in Table 4.1. Telehealth in the elderly or geriatric population was the most common topic.

Table 4.1 Areas examined for home telehealth applications

Area of study	RCTs	Non-RCTs
General homecare (chronic heart failure, chronic obstructive pulmonary disease, diabetes, anxiety, wound care)	2	2
Diabetes	4	
Cardiac disease	2	5
Hypertension	2	4
Neonates / infants / children	1	3
Elderly / geriatric		9
Other (oncology, triage, IV therapy, hospice care, spinal cord injury, asthma)		10
Policy related		18

Origin of studies

Countries in which the studies were carried out are shown in Table 4.2.

Table 4.2 Origin of home telehealth studies

Country	Number of studies
USA	33
UK	10
Australia	4
China	3
Italy	2
Canada	1
Belgium	1
France	1
Germany	1
Greece	1
Ireland	1
Israel	1
Italy	1
Japan	1
Norway	1
Spain	1

Home Telehealth Applications and Social Determinants of Health

Very few studies directly addressed any of the social determinants of health identified for this review and resulted in rejection of many studies when full papers were reviewed. Many studies were descriptive in nature and therefore were given a 'poor' evidence categorization. This, however belies the considerable weight provided by the many examples of home telehealth applications available in the literature. Lacking is consistent use of defined outcome indicators or evidence of impact on any social determinants of health. The most commonly addressed variable was cost for either the healthcare system or the patient, with many papers indicating the potential for significant cost savings for one or both. However, as described elsewhere in this report, the rigour of studies in regard to economic analysis is very poor raising concern and scepticism for such claims. The next most common socio-economic variable considered was quality of life.

Indications from the reviewed papers are as follows:

General tele-homecare

This included telehealth applications for two or more of chronic heart failure, chronic obstructive pulmonary disease, diabetes, anxiety, or wound care. Methodological limitations existed, but there seems good evidence (two RCTs, two non-RCTs) that telehealth interventions (video- or telephone-based) can improve quality of life in different populations, and reduce hospital days of care or clinic visits (Wasson et al. 1992; Noel and Vogel, 2000; Kobza et al., 2000; Mair et al., 1999). Other studies showed notable cost savings for patients, homecare agencies, and the healthcare system, mainly through improvements in efficiencies (e.g. travel time redirected to patient care, permitting a two-fold or more increase in patient handling).

Diabetes

Good evidence (5 RCTs) exists for the use of telehealth to improve the quality of diabetes care, including improved self monitoring and self-care, and better physiological control (Biermann et al., 2000; Dansky et al., 2001; Mease et al., 2000; Piette et al., 2001; Tsang et al., 2001). Modalities have included video- and telephone-based interventions. Benefits to patients include improved access to care and quality of care, and reduced costs. Telehealth can also reduce after-hour on-site visits by remote access to insulin infusion pumps. Potential future cost savings to the health care system and to the patient from avoided or delayed complications have not been estimated.

Cardiac disease

Good to fair evidence (2 RCTs; 5 non-RCTs) exists for use of telehealth as an acceptable and reliable tool to monitor chronic heart failure and pacemaker patients (Jerant et al., 2001; de Lusignan et al., 2001; Barbaro et al., 1997; Heidenrich et al., 1999; Shah et al., 1998; Srikanthen et al., 1997; Stewart, 1999). Some studies show substantial reductions in hospital readmission, emergency department visits, and overall cost of care. Modalities included telephone-based as well as video-based interventions, with some question as to the additional benefit of video capability.

Hypertension
Good to fair evidence (2 RCTs; 4 non-RCTs) exists for use of telehealth as a tool that could significantly improve care and reduce blood pressure levels of patients with essential and pregnancy-induced hypertension. This has been achieved through monitoring of blood pressure and medication compliance, and provision of education (Artinian et al., 2001; Rogers et al., 2001; Bondmass et al.,1999; Bondmass et al., 2000; Naef et al., 1998; Zhang et al., 1997). Modalities included telephone-based as well as video-based interventions.

Neonates / infants / children
Good to fair evidence (1 RCT; 3 non-RCTs) exists for the use of telehealth to support special needs of very young children (Gray et al., 2000; Horio et al., 1998; Johnson and Andrews, 1996; McCullough et al., 2001).

Elderly / geriatric
Nine non-RCTs show telehealth interventions (video or telephone based) can improve quality of life. In addition, multi-sensor monitoring in 'smart' homes can improve quality of life in different populations, and reduce hospital days of care or clinic visits. Expanded services (e.g. teledermatology) can be provided to nursing home residents in a cost effective manner that improves quality of care (Britton, 2000; Celler et al., 1995; Chan et al., 2001; Hanson and Clarke, 2000; Hui et al., 2001; Johnston et al., 2000; Rooney et al., 1997; Whitten et al., 1997; Zelickson and Homan, 1997).

Other
This category included applications in oncology, triage, IV therapy, hospice care, spinal cord injury, and asthma. Several non-RCTs support the use of telehealth in these applications. The feasibility has been clearly shown for each.

Policy-related
Many non-RCT studies contained generically good policy-related information. The potential application and value of home telehealth seems clear, and includes application not just in the 'home' but wherever the 'place of residence' may be (e.g., nursing homes, 'smart' homes). Widespread implementation will require fundamental changes in the current healthcare systems. For home-based applications the actual proportion of traditional home visits that could be performed using home telehealth appears dependent on country and patient characteristics and requires clarification in Canada. As this proportion increases so to does the potential for cost savings. Integration of home telehealth into the continuum of care and within existing healthcare systems is required. The need for clear policy and policy support of home telehealth, and for consideration of safety and risk management issues, has been identified as lacking. Additional 'lessons learned' provide guidance for implementation of home telehealth.

Overall, there is evidence for improved access to health care, improved quality of care, reduced costs from many different types of home telehealth applications focused on various patient populations.

Applicability to Alberta

Video technology suggests significant potential for increased access and increased efficiency using telehealth. There are numerous areas where video technology has been used successfully, such as with diabetic patients (Dansky et al, 2001), patients with chronic heart failure (Demiris et al, 2001; de Lusignan et al, 2001; Johnston et al, 2000), and those with spinal cord injuries (Phillips et al, 2001). Contrary to popular thinking, there are indications that seniors do not generally have "technophobia" as is commonly believed. The benefits from these applications have included cost savings to the system, improved clinical outcomes, quality of care and quality of life.

There is a great deal of support for the application of telephone interventions (Artinian et al, 2001; Biermann et al, 2000; Jerant et al, 2001; Noel et al, 2000; Piette et al, 2001; Subirana Serrate et al, 2001; Wasson et al, 1992). This support emphasises the need to not discount or discard use of simple strategies such as preventative telephone-based patient care.

The study by Subirana Serrate et al (2001) compared "home hospitalization" (i.e., homecare with 24-hour telephone support by a physician, as well as hospital-like care delivered by specialized nursing team) to inpatient care for oncology patients. This may be of interest in the Alberta environment but the issues of cost-effectiveness and breadth of application require further investigation. It is important to identify those specific populations that could most benefit from telehealth.

There have been many other examples of successful home telehealth interventions (Gray et al, 2000; Mease et al, 2000; Rogers et al, 2001; Tsang et al, 2001). In a study done on diabetes patients, an electronic diary was used to help manage patient care from home (Tsang et al, 2001). This demonstrates the value of a model that uses forthcoming wireless technology applications in a population that is at risk for increasing morbidity (note the current SLICK program in Alberta). Clinical outcomes are not the only benefit of using these types of home-based technologies. Additional benefits include quality of care, and satisfaction with care, education for patients and families, as well as emotional support for families.

There is a need to consider user readiness regarding telehealth applications (Hanson et al, 2000). This requires identification of those categories or groups of patients and caregivers that could most benefit, while at the same time not assuming value to all patients and all caregivers at all times. This is an essential consideration when implementing a broad-based program.

Summary of Economic Analysis

The studies in tele-homecare involved several different patient groups (e.g., diabetic patients, oncology patients). They all introduced a new telemedicine service to replace either patients' hospital visits or the homecare visits of health care staff. The economic analysis showed that telehealth applications are as costly or cheaper than conventional alternatives. Only one of the studies used the societal perspective in the analysis, which indicates that some analyses may be underestimating the real societal costs and savings of

these alternatives. The economic quality score values of the studies were moderate or good.

Although there is evidence that tele-homecare services can be cost-saving, more studies in the field are needed to confirm these results in Canada and Alberta.

Chapter 5: Tele-Mental Health

Highlights

- Improved outcomes and implications for quality of care were found in telephone-based interventions for patients with depression. A telephone-based behaviour therapy program could be effective for persons in rural areas with agoraphobia.

- Cost savings to health services and/or patients through the use of videoconferencing were found in five studies of telepsychiatry. Implications for cost efficiency were also found when doing video interviews with clients for neurpsychological rehabilitation.

Statistics on the literature

From the search for randomized controlled trials (RCTs), 19 abstracts were identified that appeared to describe randomized studies related to tele-mental health and 10 were selected for further review. Of these, three were subsequently excluded (one a feasibility study and two not dealing with telehealth). One study, which was not an RCT, was included with the non-randomized studies.

A total of 199 abstracts related to non-randomized studies were identified of which 74 were identified for further review. Eight articles were selected for analysis. Two papers related to a qualitative study that applied to several areas of telemedicine and were not considered for this chapter. The remaining 64 papers were rejected for analysis. Some of the selected non-randomized studies rated as "Fair to Poor" or "Poor" on the Jovell & Navarro-Rubio scale due to study design, but offered innovative programs and potential socio-economic impact.

Analysis of the 16 included studies can be found in Appendix I – Critique Mental Health

Areas of application

The general areas covered by the selected studies are shown in Table 5.1. Telepsychiatry, covering management of a range of mental health conditions, was the most common topic.

Table 5.1 Areas of study for tele-mental health applications

Area of study	RCTs	Non-RCTs
Depression, primary care	3	
Panic disorder, agoraphobia	1	
Neuro-psychological rehabilitation	1	
Dementia caregiver support	1	1
Telepsychiatry		6
Behavioural modification - obesity		1
On line forum [obesity/abuse/psychiatry/anxiety disorder]		1
Telephone support for family physicians		1

Origin of studies

Countries in which the studies were carried out are shown in Table 5.2.

Table 5.2: Origin of tele–mental health studies

	Number of studies
USA	8
Canada	4
Australia	1
China (Hong Kong)	1
Finland	1
Norway	1

Mental Health Applications and Social Determinants of Health

Indications from the reviewed papers are as follows:

Depression in primary health care
While there were some methodological limitations in the studies, there seems good evidence (Hunkeler et al, 2000; Lynch et al, 1997; Simon et al, 2000) that telephone–based interventions can improve symptoms of depression in different populations. This has implications for access to health care, quality and probably costs.

Panic disorder – agoraphobia
There is fair evidence from a small-sample RCT (Swinson et al, 1995) that a telephone-based behaviour therapy program can be effective for persons in rural areas who have this condition. This has implications for access and quality of care.

Neuropsychological rehabilitation
Schopp et al (2000) demonstrated that, in a small RCT in a US setting, video interviews with clients are accepted by clients and are cheaper than face-to-face interviews (either at a major centre or through outreach). This suggests implications for cost efficiency, avoidance of travel and access to services.

Dementia caregiver support
Mahoney et al (2001) does not provide convincing evidence that a telephone–based intervention was able to help family caregivers to persons with Alzheimer's Disease in a US setting. There is fair-poor evidence (Strawn et al, 1998) that a telephone based intervention (caring caller) was helpful in the short term to caregivers of persons with dementia.

Telepsychiatry
Five of the studies on telepsychiatry (Simpson et al, 2001; Mielonen et al, 2000; Trott & Blignault, 1998; Elford et al, 2001; Tang et al, 2001) showed cost savings to health services and/or patients through use of videoconferencing. There were no other comparative data in these studies, which also included details of satisfaction surveys. The remaining study (Rohland, 2001) gave poor evidence of the influence of videoconferencing on Global Assessment Function scores in a rural population.

Behaviour modification
A small cohort study (James et al, 2001) gave fair-poor evidence that a weight loss intervention delivered through telemedicine was as effective as an in-person program, in a US military setting.

On-line forum (various disorders)
There is poor evidence from a survey approach (Kummervold, 2001) that use of an Internet-based forum influenced use and perceptions of mental health services.

Telephone support for family physicians
Fair-poor evidence from a survey-based approach (Kates et al, 1997) suggested that providing telephone back-up by psychiatrists for family physicians is an effective support mechanism and reduces utilization of mental health services.

Applicability to Alberta

Tele-mental health through the Alberta Mental Health Board initiative is the most integrated telehealth application in Alberta. To continue and advance this work, findings from this review which could potentially offer further benefits to Albertans are listed below. However, the effectiveness and benefits/costs of some of the interventions would need to be validated in the Alberta setting.

Video-based technology
- Telepsychiatry: mental health counselling via video (Mielonen et al, 2000, Finland; Rohland, 2001, USA; Tang et al, 2001, Hong Kong; Trott & Blignault, 1998,

Australia). Suggested socio-economic benefits of telepsychiatry include improved access, improved health outcomes, satisfaction, and cost savings.

- The study by Simpson et al (2001) in Alberta, Canada, involved a breakeven cost analysis of a telepsychiatry service. Results of this study have informed decisions to expand the tele-mental health service on a province-wide basis

- Neuropsychological assessment via video (Schopp et al, 2000)

Computer-based technology

- Online mental health support groups (Kummervold, 2001)

Telephone-based applications

- Telephone follow-up for patients with depression (Simon et al, 2000)

- Behaviour therapy program for patients with agorophobia, delivered via telephone (Swinson et al, 1995)

- Telephone link between family physicians and psychiatrist to assist in patient management and to avoid unnecessary referrals (Kates et al, 1997)

- Telephone intervention to provide support to caregivers of individuals with dementia (Strawn et al, 1998)

Summary of Economic Analysis

(For full details refer to Chapter 11: Economic Analysis.)

In most cases, there were cost savings associated with the tele-mental health applications. In instances where the patients (and their caregivers) or health care professionals have to travel long distances for services, the break-even point where the telehealth alternative becomes cost-saving can be relatively low. In some cases telepsychiatry is the only feasible/economical way of delivering mental health services to rural and remote places. The inclusion of patients' and caregivers' travel costs is important in decision-making, since specialized psychiatric services (e.g., in Paediatrics) are generally only available in big cities.

The quality of the economic studies ranged between 2 and 7 on the Drummond scale; however, in general, the economic quality of the studies in tele-mental health was among the highest of all the subject areas in this review. Many of the study results are applicable to the Alberta health care environment.

Chapter 6: Teleradiology

Highlights

- Avoidance of patient transfer and evidence of cost savings were the most common areas of benefit in teleradiology. Cost-effectiveness can depend on economies of scale in terms of workload and distance.
- Potential quality of care enhancements include the elimination of some procedures and shorter time for patients to be informed of exam results.
- Telehealth can enhance educational opportunities for health care providers.
- Benefits to patients and their families such as improved access to health services, avoidance of travel and more rapid provision of care seem important factors associated with successful teleradiology services.

Statistics on the literature

From the literature search, 11 abstracts were identified that appeared to describe randomized studies related to radiology, 7 of which were selected for further review. Of these, three were subsequently excluded (all were concerned with assessing accuracy/feasibility of telemedicine links). Three randomized controlled trials (RCTs) were included for analysis in this chapter. A fourth study, which was not an RCT, was also included with the non-randomized studies.

A total of 589 abstracts related to non-randomized studies were identified of which 87 that potentially dealt with primary studies were selected for further review. A further 5 abstracts were referred for consideration after being located in searches for other parts of the project. Twenty-four papers were included for analysis in this chapter. Three papers were considered as part of the chapter on Paediatrics. Sixty-five papers were excluded from analysis, five of which duplicated findings reported previously. Of the excluded papers, 13 were identified as including potentially useful material related to socio-economic impacts of teleradiology.

Analysis of all 28 included teleradiology studies can be found in Appendix J – Critique Teleradiology.

Location of studies

The countries of origin of the studies and the settings for teleradiology are shown in Tables 6.1 and 6.2. The two studies from Hong Kong related to the same program. The Canadian study was from Alberta.

Table 6.1 Countries in which selected teleradiology studies were conducted

Country	Number of studies
USA	9
UK	4
Australia	2
China (Hong Kong)	2
France	2
Germany	2
Norway	2
Austria	1
Canada	1
Finland	1
Italy	1
South Africa	1

Type of Teleradiology Link

The most common form of teleradiology link covered by the studies involved communication between a major hospital and small hospital(s). These included six studies that considered management of neurosurgical cases, an area of success for teleradiology that has been noted in earlier reviews.

Table 6.2 Teleradiology links in selected studies

Type of teleradiology link	Number of studies
Small hospital – large hospital	17
Clinic or practice – hospital	4
Clinic and practices or small hospitals	1
Home care, follow up – hospital	3
Within hospital	1

Areas of benefit

Areas of benefit from teleradiology found in the studies are shown in Table 6.3. Avoidance of patient transfer and evidence of cost savings were the most common categories. Three studies used breakeven analysis approaches to indicate conditions for achieving savings in various settings. A positive influence on quality of care was another important theme. There was also some reference, usually anecdotal, to education of health care providers.

Table 6.3 Areas of benefits from teleradiology studies

Area	Number of studies*
Indications of cost savings	15**
Approaches to calculation of savings	3
Reduction in transfer of patients	10
Improved quality of care	3
Influence on treatment planning	2
Reduction in adverse effects	1
Reduced travel distance for patients	1

* Some studies considered more than one of these areas
** One study found that teleradiology was not cost-saving

Teleradiology applications and Social Determinants of Health

The results reported from the comparative studies on teleradiology are mostly directed towards issues of efficiency, with emphasis on cost savings and avoidance of patient transfer. There is also some evidence of impact on quality of care.

Influence of teleradiology on other social determinants of health is likely but less well established by available studies. Benefits to patients and their families from aspects such as improved access to health services, avoidance of travel and more rapid provision of care seem important factors associated with successful teleradiology services. However, in the studies reviewed such aspects were, for the most part, covered only by anecdotal accounts and to some extent by the results of satisfaction surveys. Benefits to remote health care providers through education was seen as another area of benefit, though not supported by comparative data.

Quality of evidence

The quality of available evidence of benefit from teleradiology is somewhat limited. Only three RCTs were located, one of poor quality. In another of the RCTs, the demonstrated benefits to health services were only in part attributable to telemedicine – which was one component of a broader intervention. Many of the non-randomized comparative studies provide limited detail and must be considered as giving weak evidence.

Comment on selected non-comparative studies

While the strength of evidence is lower than that in the comparative studies referred to previously, several non-comparative studies on teleradiology provide useful additional information.

Six studies gave general descriptions of the establishment and operation of teleradiology services, with indications of benefit through avoidance of patient transfer to major centres. These accounts tend to complement the material discussed previously. Six other

studies give indications of improvements to the quality of care through use of teleradiology and one refers to benefits through reduction in travel time for physicians.

There was one qualitative study on teleradiology done by Franken et al (1996) which provided evidence of good quality. It examined perceived quality of teleradiology services by rural and central (urban) radiologists, technicians, and administrative personnel. The study employed both quantitative and qualitative methodologies. One positive perception was that teleradiology reports were as accurate as those from on-site radiologists. Negative perceptions included problems with oral and written communications. It is apparent in this study that on-site (i.e., central site) and rural radiologists, and technicians, differ in their demands and expectations regarding teleradiology. This study indicates the importance of understanding the human dimensions associated with telemedicine.

Applicability to Alberta

The successful implementation and use of cost-effective teleradiology solutions in providing and supporting clinical services and decision-making has been a challenge for most jurisdictions, Alberta included. This study's results can be helpful in identifying, planning and implementing future initiatives.

Teleradiology has been shown to provide benefits such as improved patient management, quality of care, and cost savings, especially for remote and isolated populations. A number of interventions described in the literature may be applicable, particularly for communities in rural and Northern Alberta. One of the studies was undertaken in Alberta. Other studies gave results that seem generally applicable to the province, while some incorporated certain aspects that are applicable (often principles of operation or evaluation), though actual values obtained and health care settings used did not correspond closely to the situation in the province.

The studies listed below demonstrate aspects of socio-economic benefit which appear to have the greatest potential for Alberta. (See also Appendix J: Critique Teleradiology.)

Teleradiology (image transmission)

- Neurosurgical applications (Heautot et al, 1999, France; Goh et al, 1997, Hong Kong; Fery-Lemonnier et al, 1996, France; Eljamel & Nixon, 1992, UK; Spencer et al, 1991, UK)
- Emergency CT transmission (Stoeger et al, 1997, Austria)
- Intraoperative digital radiography for diagnosis of nonpalpable breast lesions (Diekmann et al, 2000, Germany)
- Military applications (Brumage et al, 2001, USA; Bergmo, 1996, Norway)
- Tele-ultrasound – obstetrics (Malone et al, 1998, USA)
- Telephonic fetal heart rate monitoring plus in-home midwifery support for high-risk pregnancies (Dawson et al, 1999, UK)
- Nuclear medicine telediagnosis (Tually et al, 2001, Australia)
- General (Franken et al, 1996, USA; Halvorsen & Kristiansen, 1996, Norway)

Teleradiology with video consultation

- Neurosurgical applications (Poon et al, 2001, Hong Kong; Maass et al, 2000, Finland; Bailes et al, 1997, USA)
- Follow-up of trauma patients (Boulanger et al, 2001, USA)
- Cardio-thoracic application (Steckel et al, 2000, USA)
- Urological application (Hayes et al, 1998, USA)
- Teleradiology case conference system in Oncology (Teslow et al, 1995, USA)
- General (Lehmann et al, 1997, Germany)
- Fetal tele-ultrasound consultation service (Chan et al, 2001, Australia; Fisk et al, 1996, UK)

An Alberta study (Johnson et al, 1998) found that teleultrasound services to a remote community were feasible and effective. Image quality and satisfaction of sonographers and patients were not considered.

Telephone-based applications

- Telephone follow-up of children who had had chest radiography (Swingler and Zwarenstein, 2000, South Africa)

Summary of Economic Analysis

(For full details refer to Chapter 11: Economic Analysis.)

The studies in teleradiology show that cost savings do occur in several different areas of application. The most convincing evidence is found in teleneurology / teleneurosurgery, involving the transmission of CT and MR images. In some settings, cost savings do occur when transmitting x-ray images, if workload and distances are great enough. The studies show cost savings both in the consultations between primary and secondary care and between specialty consultations. The cost analysis was primarily from the perspective of the health care sector. The economic quality of the studies ranged from 1 to 8. It is likely that there are some teleradiology applications that are economically feasible in Alberta.

Only one economic study from ultrasound was found in the search. The transmission of ultrasound images utilizes videoconferencing technology. This means that the incremental cost of sending ultrasound images is not high, especially if one or both sites already have videoconferencing equipment. The study by Malone et al (1998) included a telemedicine network of obstetric services with a relatively high frequency of examinations per month (200 per site). With a lower patient volume the pay-back time of the investment would be longer. If conventional services are provided by visiting a specialist, the high travelling costs may make the telemedicine alternative cost-saving given a relatively low number of examinations per year; however, there was no cost calculation of this alternative.

Chapter 7: Renal Dialysis Telehealth

Highlights

- There have been few studies in this area of telehealth.
- Utility has been demonstrated for both haemodialysis and peritoneal dialysis.
- Primary benefits include convenience, cost, and travel savings for patients.

Statistics on the Literature

From the search for randomized controlled trials (RCTs), 3 abstracts were identified that appeared to describe RCTs related to dialysis and all were selected for further review. All were subsequently excluded since they did not represent RCTs, each describing a non-randomized study, and were then considered with the other non-randomized studies.

A total of 77 abstracts related to non-randomized studies were identified, of which 15 were identified for further review. One paper was in Italian and was excluded, and two other papers that represented repetitions of material covered in other reports were also excluded. Due to the small number of remaining reports (12), all were included for review. Analysis of the reports is given in Appendix K: Critique Renal.

Areas of application

Telehealth has been used in the two primary clinical applications of dialysis: haemodialysis and peritoneal dialysis, as shown in Table 7.1.

Table 7.1 Areas examined for dialysis applications

Area of study	RCTs	Non-RCTs
Haemodialysis		7
Peritoneal dialysis		4

Origin of studies

Countries in which the studies were carried out are shown in Table 7.2. Two of the reports from the US discuss the same program, whereas those from Canada describe distinct programs.

Table 7.2 Origin of tele-dialysis studies

Country	Number of studies
Canada	3
USA	3
Australia	1
Germany	1
Greece	1
Italy	1
Japan	1

Dialysis applications and Social Determinants of Health

There is a surprising dearth of studies for the application of telehealth to dialysis. Given the continuing rise in the number of patients receiving costly dialysis treatment, that end stage renal disease represents a major morbidity for common diseases (e.g. uncontrolled diabetes), that treatment often means the need to travel to central locations for treatment, and that integration of monitoring technology with dialysis machines is relatively simple, the lack of telehealth application in this area was unexpected. Also unexpected was that the highest number of distinct studies had taken place in Canada (British Columbia, New Brunswick, and Ontario). As might be expected, very few of the studies directly addressed any of the social determinants of health identified for this review. Most reports were descriptive in nature, explaining the technology, telehealth, and dialysis process. Several were 'old' reports by telehealth standards, extending back to applications performed in the early 1990's. Studies extended from simple remote clinical monitoring of the dialysis process, through video consults and interaction with clinicians and patients, to remote adjustment of parameters during dialysis.

Indications from the reviewed papers are as follows:

Haemo- and Peritoneal Dialysis

The lack of RCTs represents a concern, and highlights the methodological limitations of the available studies. At best, current evidence could only be described as poor to fair. However, the apparent sustained nature of some of the dialysis programs would indicate that clinical and economic value exists. Certainly each study identified better access, equivalent or better quality of care, and reduced travel for patients as major benefits. The studies conducted in Canada might be of particular interest: Cresswell and Hicks, 1996; Going, 1998; Picot et al., 2001.

Applicability to Alberta

End stage renal disease is a common outcome for uncontrolled diabetes. As a consequence, the prevalence of diabetes in the First Nations population, as well as its occurrence in the general Albertan population, might imply some specific basis for applicability of interventions via telehealth. However, given the results of this review, only cautious and rigorous investigation could be recommended, until such time as clearer evidence of the value of telehealth for renal dialysis patients becomes available.

Summary of Economic Analysis

The review did not find any good economic studies related to renal dialysis. Telehealth applications in renal dialysis are mostly videoconferencing connections between satellite clinics and university clinics. The connections are used to supervise and monitor the care given in the satellite clinics, and to give specialized care consultations to satellite care patients in specific renal dialysis related conditions. There are also telehealth applications in home dialysis care, although they do not include proper economic analysis. The economic issues around renal dialysis cooperation via telehealth are significant, since patients require treatment several times per week. Problems in care may lead to substantial additional costs in ambulatory care with ambulance transportations and hospitalizations. More analysis is needed in the area to demonstrate cost-effective methods of maintaining high quality renal dialysis care in remote and rural satellite units and home dialysis.

Chapter 8: Rural & Remote Telehealth

Highlights

- Utility has been demonstrated for broad clinical uses.
- Other than cost, few socio-economic indicators have been addressed.
- A need exists for policy development.
- Policy leadership will greatly facilitate use of telehealth.
- As telehealth use increases the per-contact episode cost is likely to decline.
- Human factors such as 'rural ownership' of telehealth solutions must be addressed.

Although often inadequate from a scientific viewpoint, the results of telehealth evaluations to date have been consistent in showing that telehealth technology works for many clinical needs, and that patients are happy with it. However, examination of the social, organizational, and policy aspects have been largely overlooked.

No studies identified or defined specific socio-economic outcome indicators. Clinical outcomes were addressed, but very few studies examined the effectiveness of telehealth in improving health status or the outcomes of health care.

Statistics on the Literature

The literature search identified a total of 1051 abstracts related to rural and remote telehealth. From these, 155 articles were selected for further review. The final set of articles which were included for analysis in rural and remote telehealth consisted of five randomized controlled trials (RCTs) and 30 non-randomized studies. Reasons that the remaining 120 articles were rejected were that 1) the articles did not pertain to telehealth or 2) the articles did not contain any good to fair evidence for telehealth nor any reference to socio-economic indicators.

Analysis of the selected studies is given in Appendix L: Critique Rural Remote.

Areas of Application

Telehealth has been examined in a broad spectrum of applications in rural and remote communities. The general areas covered by the selected studies are shown in Table 8.1. Teleconsultation, which covered administrative and educational activities in addition to the clinical applications noted, was the most common application of telehealth.

Table 8.1. Areas examined for rural and remote applications

Area of study	RCTs	Non-RCTs
Teleconsultation (radiology, cardiology, colposcopy, psychiatry, emergentology, dermatology, neurology, other)	2	9
Outpatient follow-up		1
Internet-based consultation	1	1
High-risk / rare disease patients (antenatal care, paediatric cardiology, sickle cell)		3
Telephone support (telecare / teletriage)	2	2
Nutrition		2
Policy related		12

Origin of Studies

Countries in which the studies were carried out are shown in Table 8.2.

Table 8.2. Origin of rural/remote telehealth studies

Country	Number of studies
USA	13
Canada	8
Australia	5
UK	4
Germany	1
Greece	1
Italy	1
New Zealand	1
Norway	1

Rural & Remote applications and Social Determinants of Health

Very few studies directly addressed any of the social determinants of health identified for this review. This was the sole reason for rejection of most studies when full papers were reviewed. Most studies were descriptive in nature, often recounting the technology and telehealth process, but not identifying suitable outcome indicators or providing evidence of an impact on any identified socio-economic determinant of health. The most commonly addressed variable was cost for either the healthcare system or the patient, with many papers indicating the potential for significant cost savings for one or both. However, as described elsewhere in this report, the rigour of studies in regard to economic analysis is very poor, raising scepticism for such claims. When considering

investment in rural and remote telehealth solutions, a major policy consideration is that return on investment differs according to perspective (i.e., the patient, versus provider, versus system) and includes issues such as increased access.

Indications from the reviewed papers are as follows:

Teleconsultation
Some methodological limitations existed in the studies, but good evidence (two RCTs, nine non-RCTs) showed interactive-video consultation is effective and efficient, and increases access to health care (e.g. Nesbitt et al., 2000; Minister of Research, 1999; Jennett et al., 1995). The broad applicability of this modality was clear: radiology and cardiology (Bracale et al., 2002), colposcopy (Ferris et al., 2002), neuropsychology (Schopp et al, 2000), emergentology (Darkins et al., 1996), dermatology (Oakely et al., 2000). There are implications for avoidance of travel (patient and provider), quality, and possibly cost.

Outpatient follow-up
One non-RCT demonstrated the utility of telehealth for outpatient follow-up (Boulanger et al., 2001).

Internet-based consultation
Good evidence (one RCT) showed that low-technology approaches such as Internet-based exchange of images and consult requests can be effective (Vassallo, 2001). This study was specifically related to developing countries, but may have broader application. Implications again exist for access, avoidance of travel, quality of care, and cost.

High-risk / rare disease patients
Telehealth increases access for rural or remote patients with rare diseases or special needs (i.e., antenatal care, paediatric cardiology, sickle cell), without an increase in the number of specialists (Lamb et al., 1997; Tsilimigaki et al., 2001; Woods et al., 2000). Access to specialty care increased. There are implications for avoidance of travel, quality of care, and cost.

Telephone support (telecare / teletriage)
There is good to fair evidence (two RCTs, two non-RCTs) of the utility and potential value of use of the simple telephone for either teletriage/telecare or patient monitoring (Hunkeler et al., 2000; Liesenfeld et al., 2000; Piette et al., 2000). All studies lacked evidence of long-term impact. The avoidance of literacy problems when using the telephone was noted. There are implications for access, avoidance of travel, quality of care, and cost.

Nutrition
Two non-RCTs demonstrated the ability to provide nutrition counselling remotely and effectively (Johnson et al., 2001; Stiles et al., 1998). Reduced travel was the primary benefit, although there are also implications for access and quality of care.

Policy related
Generically good evidence from non-comparative studies indicates a need for development of clear telehealth-related policy. Five of the twelve policy-related studies

specifically identified the inter-jurisdictional or general telehealth policy void as an issue of immediate concern. Additional 'lessons learned' provided generic guidance for implementation of telehealth (e.g. Smith et al., 2001; Watanabe et al., 1999). . Implications exist for integration of telehealth into mainstream rural healthcare, particularly with regard to human factors outweighing technology issues (e.g. Swanson, 1999; O'Neill et al., 2000; Monrad Aas, 2002).

Applicability to Alberta

Videoconferencing is a technology that has applicability in Alberta. It has been applied to teledermatology and neuropsychological assessments, and in both areas has shown quality of care and cost benefits to patients, as well as educational benefits to physicians (Oakely et al, 2000; Schopp et al, 2000).

There have also been evaluations of videoconferencing technologies that have led to important questions of readiness. In a study done by Campbell et al (2001), the classification scheme and associated strategies for implementing new technologies in each category could assist in current and future programs.

Teleradiology is another area that has applicability to Alberta (Tually et al, 1999; Tually et al, 2001). In nuclear medicine, oncology, musculoskeletal injury and cardiovascular disease, there appears to be cost benefits to patients, quality of care in terms of referral patterns leading to early diagnosis, and education for primary care physicians.

Telephone interventions, used in their various forms for diabetic and blood pressure interventions, can be considered applicable to Alberta (Hunkeler et al, 2000; Liesenfeld et al, 2000; Piette et al, 2000). There is potential for improved clinical outcomes, as well as enhanced quality of care.

The question of diagnostic accuracy regarding telehealth is pertinent. In a study estimating the efficacy of telemedicine colposcopy for women, the diagnostic accuracy of distant experts was similar to that of on-site experts (Ferris et al, 2002). This evidence should be considered with respect to Alberta's cancer programs.

There is a need to examine the impact of telehealth and remote consultations in the job situation, as well as considering how the working environment could be improved for those involved in telehealth (Monrad Aas, 2002). There are many positive aspects of telehealth, such as benefits related to travelling (less travelling to see patients and less need to travel in bad weather) and an increased sense of professional communication and security.

Summary of Economic Analysis

Rural and remote telehealth applications involve several different specialty areas that utilize different technologies, hence they are difficult to compare and summarize. Generally, the studies showed that it is economically feasible and in most cases cost effective to use telehealth in rural/remote consultations. However, that conclusion cannot be applied to all rural sites and to all specialties in Alberta and northern territories, since some of the studies involved considerably greater volumes of patients than are present in parts of rural or northern Alberta. If health care provider costs only are included, the telehealth alternative is not always cost-saving. However, if patients' travel and lost working time are included, many of the telehealth alternatives become cost-saving from a societal perspective. In addition, it is very difficult to measure the value of increased access to care, equity in health, and the value of health care staff education during consultations to remote and rural areas.

The quality of economic studies in the field varied greatly (between 1 and 8). More economic studies are needed that are specially connected to the rural/remote environment in Canada and Alberta since there may be some variation as compared with the US or UK environments.

Chapter 9: Telerehabilitation

Highlights

- Educational interventions delivered by telephone or video can improve clinical outcomes and reduce hospitalization rates.
- Home-based transtelephonic exercise monitoring for cardiac rehabilitation patients is an effective alternative to a hospital-based program, and provides socio-economic benefits to patients (e.g. access, cost).
- Use of computer software can help children with hearing impairments improve speech perception and speech production skills.
- Use of videoconferencing for patient assessment has evidenced acceptability in neuropsychological rehabilitation and was shown to be effective in spinal cord injury rehabilitation and to result in more patients returning to work. Telehealth has the potential to improve access to assistive technology assessment/intervention for disabled patients.
- It is suggested that telerehabilitation programs enhance patient involvement in care and patient independence.

Statistics on the literature

A total of 117 articles and other sources which appeared to be related to telerehabilitation were identified in the literature search. These consisted of 11 randomized controlled trials (RCTs) and 106 non-RCTs. Upon review of abstracts, 39 were selected for further review, four of which were RCTs. One RCT pertained to Paediatric teleradiology and is included in the teleradiology chapter. Evidence from the remaining three RCTs was rated as good and good-fair, and the results are reported in this chapter.

Of the 35 non-RCTs, three provided good-fair evidence of the effectiveness of telehealth in certain applications. Thus there were a total of six RCTs and non-RCTs providing Good to Fair evidence in accordance with the 1995 Jovell/Navarro-Rubio scale (Hailey et al, 2002). Fifteen other studies were included for comment as they presented insights or policy implications in telerehabilitation related to social determinants of health. These studies were descriptive (non- experimental) or were non-randomized controlled trials, non-controlled clinical series, or case reports where the strength of evidence was poor.

Analysis of the 21 included studies can be found in Appendix M – Critique Telerehabilitation.

Location of studies and areas of application

Tables 9.1 and 9.2 indicate the areas of study and the country of origin, respectively, of the telerehabilitation studies.

The spinal cord injury (SCI) and wound assessment studies were conducted at the Shepherd Centre in Atlanta, US. The Shepherd centre is a rehabilitation hospital serving people with disabilities following catastrophic injury or illness affecting the central nervous system (Burns et al, 1998). Three other descriptive studies pertaining to wound care at the Shepherd Centre were identified; these are included for comment in the section on non-comparative studies.

Table 9. 1 Areas of study for telerehabilitation applications

Area of study	RCTs	Non-RCTs
Spinal cord injury	1	
Wound assessment		1
Cardiology	2	
Paediatrics		1
Acquired brain injury		1

Table 9.2 Origin of telerehabilitation studies

Country	Number of studies
USA	5
Canada	1

Telerehabilitation applications and Social Determinants of Health

Table 9.3 lists the general areas of benefit in telerehabilitation.

Table 9.3 Areas of benefit from telerehabilitation studies

Area	Number of studies*
Cost / CE / health system utilization	2
Education	1
Acceptability / client satisfaction	2
Quality of care	1
Quality of life	3

* Some studies considered more than one of these areas

Spinal cord injury (SCI)

There is good evidence in the preliminary results of the Phillips et al (2001) study that SCI patients who receive structured education sessions via telephone or videoconference have higher quality of life scores than controls. In addition, annualized hospitalization rates were 3 days for the video, 5 days for the telephone and 8 days for the standard care group.

Wound Care

Phillips et al (1999) found that weekly video and telephone counselling sessions for SCI patients were feasible for assessing pressure ulcers. There were more pressure ulcers identified in the video group. The authors suggest that assessment and identification of ulcers was facilitated by videoconferencing.

Telehealth was not economical from a health system point of view as annualized Emergency Department visits, hospitalizations and health care provider visits were lower or the same in the standard care group. However, substantially more people in video intervention group returned to work. This is an important social indicator. The authors suggest that telehealth may promote self-efficacy among SCI patients, thereby leading to better community reintegration and adjustment.

Cardiac telerehabilitation

In a randomized controlled trial of provision of web-based education and support for cardiac rehabilitation patients, the treatment group rated resources as useful in providing information, enhancing quality of life, coping with their disease and reducing social isolation (Bates et al, 2001 - 2 articles submitted for publication). At seven months post-intervention, there were no differences in cardiac risk factors, but the treatment group scored significantly lower on the quality of life scale and higher on the depression scale. The authors discuss possible reasons for this unexpected result and suggest that use of telehealth for secondary prevention requires further study.

Sparks et al (1993) conducted a small-sample RCT to evaluate home-based transtelephonic exercise monitoring program versus a hospital-based program. The two groups had statistically equivalent improvements in functional capacity and exercise compliance. The authors conclude that at-home exercise is an effective alternative to a hospital-based program.

The advantages of home-based for cardiac rehabilitation patients may include flexibility of timing/scheduling, reduced travel and increased family support. This telehealth application may be a strategy to increase patient compliance in rehabilitation programs and thus enhance health outcomes.

Telerehabilitation for children with hearing impairment

Zwolan et al (2000) studied speech perception in children with severe sensorineural hearing loss which had occurred prior to age 15 months and who had cochlear implants. The intervention group patients used the Foundations in Speech Perception (FSP) software program on a daily basis in their homes for a period of six months. Improvements in the intervention group were significantly greater than controls on two speech recognition tests. Those who used the software more frequently experienced

greater improvement. A questionnaire provided to parents indicated a high level of satisfaction with FSP software.

Acquired brain injury

Schopp et al (2000) evaluated the acceptability of videoconferencing for neuropsychological assessment. Fifty-two patients with cognitive dysfunction were interviewed via videoconference and 52 age- and diagnosis-matched controls were interviewed in person. Those assessed by videoconference were more likely to want to repeat their experience. Both groups reported equally feeling relaxed and feeling that the neuropsychologist showed caring. On the other hand, the neuropsychologists were less satisfied with the videoconference system.

Non-comparative studies

The following potential socio-economic benefits were identified in the descriptive literature in telerehabilitation:

Access

- Telerehabilitation has great promise for expanding availability, accessibility, affordability of services for persons with disabilities, e.g., assistive technology specialty services (Malagodi & Smith, 1999; Burns et al, 1998).

Cost

- Telerehabilitation can save patients' travel time and costs (Vesmarovich et al, 1999).

Quality of care

- Diagnosing skin conditions through verbal description alone is not reliable, thus video-based interventions can be an effective way to assist patients and provide them with education (Phillips et al, 1998).

Artunian (1997) suggests the following advantages related to quality of care:

- Telemedicine can facilitate assessment of certain problems that occur a specific situations (e.g., infant feeding problem);
- A video link to the patient's home can give the provider more insight into problems related to the family or the home itself;
- With respect to coordination of care, telehealth makes it easier for others involved in a child's care to participate in their rehabilitation; i.e., therapists, social workers, case managers.

Empowerment

- A key advantage proposed by Hauber et al (1999) is that telerehabilitation empowers consumers to take an active role in their own therapy.

Independent living

- Integrated home systems technology, as described by Cooper and Keating (1996), may help to support clients (especially disabled) to live independently.

Quality of Life

- Ades et al (2000) used the Health Status Questionnaire (HSQ) to measure quality of life in a study of home-based ECG and voice transtelephonic monitoring. The HSQ includes the following domains of patient health status: general health perception, physical function, role limitation - physical and emotional, social function, mental health, bodily pain and energy/fatigue.

Health outcomes

- Computers have an important role to play in the rehabilitation of people with neurological disabilities. Specifically designed applications can enhance communication skills, motor skills, cognitive functions, social skills, mood, vocational rehabilitation and recreation/leisure activities (Stern et al, 1999). The needs of the patients and the adaptability of the computer must be taken into account when selecting suitable programs (Larsson et al, 1995).

- New technologies in virtual rehabilitation (VR) for orthopaedic patients are under development (Popescu et al, 1999). VR routines can include physical therapy (improving the patient's motor skills through exercise of muscles and joints) and functional rehabilitation exercises (regaining lost skills related to daily living or job-related skills). Telerehabilitation systems that record data from patient exercises allow therapists to remotely monitor the patient's progress.

Provider education, training, support

- A group of 39 rural mental health clinicians improved on knowledge scores after one-on-one training via videoconference. Telemedicine training and ongoing support for rural clinicians enables them to provide day-to-day management and care for patients with conditions such as brain injury, reserving specialist consultation for emergencies or complex problems (Schopp et al, 2000).

- Telehealth may help to alleviate some of the factors that contribute to stress and burn-out include in rural/remote working environments – i.e.: isolation from colleagues, high level of responsibility, no relief, and specialists find themselves also working as generalists (Jin et al, 2000).

Transtelephonic electrocardiographic monitoring (TEM) is a common telerehabilitation initiative; however, strength of evidence in many studies is not high. Squires et al (1991) describe the following advantages of TEM:

<u>*Remote site TEM*</u> (i.e., satellite clinic connected to central monitoring site)

- Enhanced patient safety and confidence due to availability of medical personnel on-site
- The remote facility does not need to purchase ECG monitoring equipment for its cardiac rehabilitation program
- Potential for better use of staff time at both remote site and central monitoring site

<u>*Home TEM*</u>

- Enhanced patient safety due to real-time ECG monitoring and communication with trained staff
- Convenience
- Enhanced patient independence with respect to the exercise program

Applicability to Alberta

There is evidence that a number of telehealth applications, for example, telephone and video care, and educational applications, computer interactive programs, and new web-based technologies can assist rehabilitation patients and providers in health, health care, quality of life, and social situations. To date evidence is strongest for telehealth use in such areas as spinal cord injury, wound assessment, cardiology, Paediatrics, neurology, and education. Current literature would suggest that further grounding is required in with respect to cost.

A possible next step for Alberta is to move forward into quality research, keeping in mind the design, results, and lessons learned from existing quality research, given that:

- Alberta has strong rehabilitation programs and expertise that already play telehealth leadership roles,
- Various low cost applications have been found to impact patient quality of life, self-efficacy, independence, community reintegration, flexibility of scheduling, reduced travel, increased family support, and decreased annual hospitalization.

In addition, there is room for product R&D in this area, as new technologies evolve and require testing and proof of concept.

Summary of Economic Analysis

The review did not identify any economic studies related to rehabilitation. The volume of telehealth applications in rehabilitation is increasing in Canada and elsewhere, hence there is an urgent need for economic assessment in this field.

Chapter 10: Telehealth Reviews

Highlights

- Evidence of efficacy & efficiency for telehealth has been demonstrated most frequently in the following areas of application: teleradiology, ECG transmission, tele-mental health, teledermatology and tele-homecare
- Telephone follow-up and reminders have become a prominent strategy in telehealth and there is evidence of cost-effectiveness.
- Decisions to use telehealth should be based on evidence showing comparable patient outcomes in the hospital/office environment and improved outcomes in homecare.
- Tele-homecare may be an effective response to changes in delivery of acute care and to the increasing population of chronically ill patients.
- Telehealth can enhance continuity of care by improving access and supporting coordination of activities by clinicians.
- Wootton (2001) recommends that an international body or national telehealth society take an overall coordination role in telehealth research.
- A number of valuable suggestions regarding evaluation and research in telehealth are provided.

Statistics on the Literature

The literature search located 124 abstracts related to telehealth reviews and 41 of these were initially selected and retrieved. A total of 29 reviews were included for analysis: 17 systematic reviews and 12 other reviews (e.g., literature reviews). Twelve reviews were excluded because they did not relate to telehealth and/or consisted of earlier articles by the same author and on the same topic as ones written later.

Analysis of the 29 reviews can be found in Appendix N: Critique Systematic Reviews

Areas of Application

The areas of application of the reviews, and number of studies covered by the reviews (if reported) are shown in table 10.1.

Table 10.1 Areas of Application of Review Articles

Area of Application	Authors	Number of studies reviewed
Systematic Reviews		
General / all types of telehealth	Currell et al, 2002	7 RCTs
	Hersh et al, 2001	25
	Balas et al, 1997	80
	Whitten et al, 2002	24
	Hailey et al, 2002	66
	Roine et al, 2001	50
	Hakansson & Gavelin, 2000	246
	Mair et al, 2000	Not reported
	Grigsby et al, 1995	Not reported
Focus on patient satisfaction	Mair & Whitten, 2000	32 RCTs
	Williams et al, 2001	93
Focus on doctor-patient communication	Miller, 2001	38
Tele-oncology	Campbell et al, 1999	15
Paediatric, obstetric, home telehealth	Hersh et al, 2001	46
Telepsychiatry	Baer et al, 1997	21 studies over 40 years
Telepsychiatry	Ball & McLaren, 1997	15
Telehealth in developing countries	Wootton, 2001	55
Other Reviews (not Systematic Reviews)		
General / all types of telehealth	Taylor part 1 1998	33
	Taylor part 2 1998	Not reported
	Loane & Wootton, 2001	Not reported
General / economic impact	Hailey & Crowe, 2000	20
General / survey of costs	Lobley, 1997	Not reported
Telepsychiatry	Capner, 2000	Not reported
Training / education	Pullum et al, 1999	5 programs, MT, USA
Teleradiology	Boland, 1998	Not reported
Tele-homecare	Kinsella 1998	Not reported
Teledermatology	Eedy 2001	Not reported
Acute & emergency telehealth	Benger 1999	6
Disaster / military	Garshnek & Burkle, 1999	11

Social Determinants of Health and Socio-Economic Indicators

Currell et al (2002) reviewed seven randomized controlled trials of telemedicine as compared with face-to-face patient care. The authors found few significant differences in clinical outcomes between groups, but some evidence of higher levels of satisfaction, improved clinical processes (e.g., medication adherence) and/or outcomes in the telehealth intervention groups.

In a review of 25 studies of home-based or office/hospital-based telehealth, Hersh et al (2001) found that telehealth outcomes were comparable or better than face-to-face care. There were modest benefits related to telehealth for chronic disease management, AIDS and Alzheimer's patients, and good evidence for comparable care in the Emergency Department setting and benefit in surgical and NICU. It was recommended that decisions to use telehealth be based on evidence showing comparable patient outcomes in hospital/office environments and improved outcomes in homecare.

Balas et al (1997) note that telephone follow-up and reminders are two of the most prominent telehealth initiatives being trialled at present. Sixty-one of the 80 clinical trials included in the systematic review involved provider-initiated communication with patients, generally via telephone. Telehealth resulted in significantly improved outcomes in studies of preventive care, osteoarthritis, cardiac rehabilitation and diabetes. An important benefit of telehealth can be enhanced continuity of care through improved access and coordination of activities by clinicians – physicians and others.

Systematic reviews by Hailey et al (2002) and Roine et al (2001), involving 66 and 50 studies respectively, found the most evidence of efficacy and efficiency for telehealth in the following areas of application: teleradiology (i.e., CT transmission), tele-mental health, ECG transmission, teledermatology, tele-homecare and some medical consults.

In reviewing studies of Paediatric, Obstetric and home telehealth, Hersh et al (2001) found that videoconferencing, self-monitoring and store-and-forward technologies can improve access to care, quality of care, and/or clinical outcomes.

Taylor (1998) states that clear benefit has been demonstrated for:

- transmission of scans for intra-cranial injuries, and
- telephone monitoring devices to support chronic disease management.

Loane and Wootton (2001) indicate that savings associated with telehealth are greatest for patients, but that from a societal perspective, telehealth can be economically viable when distances are substantial.

Concerns have been raised regarding the economic impact of telehealth on the health system; i.e., that telehealth may shift rather than save costs (Hakansson and Gavelin, 2000), and that improved access to care via telehealth will increase costs (Lobley, 1997; Boland, 1998).

The Patient Perspective

Three systematic reviews focused on specific aspects of patient perspectives in telehealth. Mair and Whitten (2000) focused on patient satisfaction with real-time video consultation, concluding that teleconsultation is acceptable to patients in a variety of applications but that the effect of telehealth on communication processes and interpersonal relationships requires further study.

In a review of 93 studies involving mainly videoconferencing technology, Williams et al (2001) found that reported levels of satisfaction with telehealth are consistently higher than 80%. However, the majority of studies were descriptive, lacking a control group for comparison.

Miller (2001) researched the effect of telehealth on doctor-patient communication, and identified the following important factors:

Factors rated positively overall:
- general communicative efficacy
- patient/provider comfort
- patient/provider relations
- level of anxiety
- audio quality
- video quality

Factors rated negatively overall:
- non-verbal behaviour
- lack of touch

Oncology

Campbell et al (1999) reviewed 15 studies in comparing tele-oncology to conventional methods of providing cancer treatment to rural and remote populations. They concluded that tele-oncology was cheaper than outreach clinics but at least double the cost of central clinics.

Mental Health

In a review of 21 studies of telepsychiatry, Baer et al (1997) found that telepsychiatry is feasible and well accepted by patients and doctors but is rated inferior to face-to-face consults. There are methodological deficiencies in the studies reviewed (i.e., most uncontrolled), therefore the results may not be generalizable. Programs in Alberta have demonstrated utility in telepsychiatry.

Ball and McLaren (1997) suggest that telephone and video-based cognitive assessment has been shown to be feasible; however, few methodological details were provided.

Teleradiology

Teleradiology and teleconsultation, using store & forward and videoconference technology, is becoming standard practice for assessment of minor injuries from remote clinics in UK (Benger, 1999).

Teledermatology

With respect to teledermatology applications, Eedy (2001) suggests that store & forward technology has a cost-effectiveness advantage over videoconferencing. The accuracy of diagnosis in teledermatology appears to be good but not as good as in face-to-face consultations.

Training/education
Telehealth can be used in the delivery of continuing education to rural and remote health care providers (Pullum, 1999).

Applicability to Alberta

Telephone follow-up and reminders have become a prominent strategy in telehealth and there is evidence of cost-effectiveness. Alberta should give due consideration to use of telephone applications in delivering distance clinical care.

Many reviews identify lack of reimbursement structures as an impediment to the advancement of beneficial telehealth initiatives. This issue has been partially addressed in Alberta but needs to be more fully resolved.

Tele-homecare is regarded as the next major step for telehealth. With the advent of SuperNet (broadband network) and the long distances that home care providers need to travel in rural communities, tele-homecare offers potential in Alberta

Benefits that could be derived from a more comprehensive introduction of telehealth in the Emergency Department environment should be considered for Alberta. This can support providers and staffing levels at remote locations. Appropriate equipment including teleradiography systems would be required.

Telehealth Evaluation / Research

Several authors state that further research is required and provide the following direction:

- Advocate use of randomized controlled trials
- As telehealth moves in to long-term use, the effects on health status, costs and organization as well as ethical, social issues, and possible risks need to be considered (Hailey et al, 2002). In evaluating tele-homecare programs, researchers should consider clinical and other relevant outcomes other than "avoided hospitalizations" (Kinsella, 1998).
- The effects of telehealth on costs, access, practice patterns, and patient management require further study (Grigsby et al, 1995)
- Approaches for economic analysis need to include sustainability of the service; decisions on equipment and telecommunications; effect on the overall use of health program resources and measurement of outcomes (Hailey et al, 2002).
- Whitten et al (2002) suggest specific types of research design to best meet specific questions; for example, analysis of opportunity costs to show value of health resources in terms of best alternative use for such resources.
- Baer (1997) suggests a 3x3 matrix to evaluate telehealth: cost, quality and accessibility assessed from the client, provider and societal perspectives. Hakansson

and Gavelin (2000) also note the importance of distinguishing cost-effectiveness from the perspectives of different stakeholders.

- Mair et al (2000) cite ten recommendations to assist researchers improve methodology of future research on cost-effectiveness.
- Lobley (1997) cites 19 questions that need to be answered in conducting a cost analysis.
- Wooton (2001) suggests having an international body or national telehealth society take an overall coordination role in running trials, performing evaluations & disseminating results.

Chapter 11: Economic Analysis

The rating of economic studies can be found in Appendix O: Economic Analysis. Articles are rated on a scale of 1 to 10 based on the Drummond et al (1997) criteria:

1. Was a well-defined question posed in answerable form?
2. Was a comprehensive description of the competing alternatives given?
3. Was the effectiveness of the programs or services established?
4. Were all the important and relevant costs and consequences for each of the alternatives identified?
5. Were costs and consequences measured accurately in appropriate physical units?
6. Were costs and consequences valued credibly?
7. Were costs and consequences adjusted for different timing?
8. Was an incremental analysis of the costs and consequences of the alternatives performed?
9. Was allowance made for uncertainty in the estimates of costs and consequences?
10. Did the presentation and discussion of the study results include all issues of concern to users?

Following is a summary of the economic analysis by subject area.

Paediatrics

Dick et al, 1999. In this study a videoconferencing link was established between Thunder Bay and the Hospital for Sick Children in Toronto. A total of 140 Paediatric patients participated. Families were satisfied with the specialist services and they estimated that they saved on average $1,318 in travel and associated costs through teleconsultation. Though the study demonstrates significant cost saving for families of Paediatric patients, the other health care related costs were not estimated.
Economic analysis quality score: 0

Finley et al, 1997. In this study, Paediatric echocardiography (ECG) images were sent by video transmission from regional hospitals to a tertiary hospital in Halifax. The costs of the telemedicine system and avoided transportation costs were estimated (from a health care perspective). The cost of telemedicine system was C$90,000 and the transportation costs avoided from 31 patients were C$100,000-118,000. Service was comparable to a conventional one and can save money.
Economic analysis quality score: 3

Mulholland et al, 1999. The authors applied normal low-cost videoconferencing equipment for the transmission of ECGs from local hospitals to a regional hospital Paediatric cardiology unit. The study includes a very limited cost estimation of the savings to the system. They found that the teleconsultation system avoided 47 ambulance transportations to the regional hospital, resulting in US$22,560 cost savings to the hospital, while the cost of the system was about US$10,400.
Economic analysis quality score: 0

Rendina et al, 1997, 1998 and 2001. The three studies by Rendina and his coauthors indicate that neonatal telecardiology from regional hospitals to an academic hospital can

be cost-effective. After modeling the neonatal data from several regional hospitals, they found that telecardiology was associated with a 58% reduction in transfers to academic centre, associated with a reduction of US$150,000 in patient transfer costs. These three studies calculate on a very general level the health care costs averted via neonatal telecardiology. The generalizability of the economic analysis is limited.
Economic analysis quality scores: 3, 0, 0, respectively.

Sable et al, 1999. The study analyzed costs of live transmission of neonatal ECGs from underserved areas and compared them to saved transportation costs (helicopter and doctor). The study showed that the videoconferencing system was accurate and that it saved five unnecessary transportations to tertiary hospital. The study did not include a proper economic analysis. A short calculation showed that the value of saved transportations was higher than the telehealth investment costs plus telecommunication costs.
Economic quality score: 0

Tsilimigaki et al, 2001. These preliminary study results suggest that a telehealth system for congenital heart disease in children may be cost-saving from the perspective of patients' families and society. However, the cost analysis was very limited.
Economic quality score: 0

Summary of Paediatrics studies
The economics of Paediatric telehealth applications was analyzed mainly from a health care provider or patient/parental perspective. From the health care perspective, the cardiologic consultations seem to be cost saving (at least after certain workload), partly because the investment cost to the system is not high, and the costs of transporting and caring for neonates in intensive care units are very high. From the patients/parents perspective, Paediatric specialist and Paediatric congenital heart disease consultations can be cost-saving for patients' families.

The quality of the economic studies was poor, since the studies fulfilled only 0 to 3 quality criteria. This means that although the results can give some initial information about the magnitude of the costs and possible cost savings, the results cannot be fully used in actual decision-making due to the likely bias of results in both directions.

First Nations

There are no economic studies of First Nations telehealth applications. Since many of these communities are rural and remote, the economic analysis in the Rural and Remote Telehealth chapter is most applicable to these patients. However, First Nations populations may have some specific socio-economic, cultural and epidemiological characteristics that might also influence the economic analysis of telehealth in this patient population. More research in this area is urgently needed.

Geriatrics

LifeMasters, 2001. The article describes a disease management solution for ill seniors. Sixty-two seniors were divided into an Internet-based intervention group, an interactive voice response (IVR) group, and patients who received usual care. No real economic analysis was described. However, the article shows that cardiac costs decreased US$246.52 per member per month in internet group and US$264.93 per member per month in IVR group. In the conventional care group, cardiac costs rose by US$134.87.
Economic quality score: 0

Riegel et al, 2002. This study examines the effect of a standardized nurse case-management telephone intervention on resource use in patients with chronic heart failure. Some of the post-discharge follow-ups were replaced by nurse telephone calls. It was found that for heart failure patients this treatment had significant outcome effects by reducing heart failure hospitalization. It had a significant impact on the reduction of acute care costs per patient (about US$1000), while the cost of the program per patient was US$443. This study included only health care costs, although it is difficult to define all the costs used in the study. The study demonstrates the potential clinical and economic benefits of telephone follow-up for chronic conditions.
Economic quality score: 4

Subirana Serrate et al, 2001. This cost-minimization analysis of oncology patients looked at two groups: those who were hospitalized at home when possible and had access to 24 hours telephone support, versus those who received hospital care. All direct variable medical care costs were provided by health insurance companies (health care perspective). The total home care cost was 64% of that of hospital care (difference not significant). The cost minimization analysis showed significant cost savings for oncology patients nursed at home with telephone support. Telephone-supported homecare was recommended. (This study also included in tele-homecare section.)
Economic quality score: 4

Pringle Specht et al, 2001. The article is a cost-minimization analysis of a pilot telemedicine chronic wound consultation clinic, from the point of view of gerontological nursing. The perspective of the study was mainly that of the health care system, although some patient costs were discussed. The average cost of a telehealth chronic wound consultation was US$136.16 versus US$246.38 for face-to-face consultation, including patient transportation. The opportunity cost of lost working time in the option where specialized nurse travels to see the patient was high (12 patient consultations missed). Telehealth cost savings are demonstrated. (This study also included in rural/remote telehealth section.)
Economic quality score: 5

Summary of Geriatrics studies

The geriatric studies employed mainly a health care perspective in the economic analysis. The quality of the few studies found in the field was weak to moderate. The results show that the telephone can be a cost saving method of providing medical advice to geriatric patients due to reduced use of hospital /nursing home services. In the long-term care setting the utilization of videoconferencing for chronic wound consultations was also

seen as cost-saving since both the transportation of chronically sick geriatric patients and visiting of specialists at long-term facilities are relatively expensive alternatives to videoconferencing. Because the evidence is based on relatively few economic studies with low or moderate quality, these results can be considered to be tentative. There is a need for more studies to confirm these results, e.g., in Alberta.

Tele-homecare

Dansky et al, 2001. A randomized study of 171 diabetic patients compared groups that did (n=86) or did not (n=85) have video visits in addition to skilled nursing visits. The study analyzed the homecare costs only and showed that, while tele-homecare imposes additional expenses for care delivery, it contributes substantial savings without compromising quality. Additionally, they found that the financial benefits increase as the duration of the patient episode increases. Therefore telemedicine is recommended.
Economic quality score: 8

Dawson et al, 1999. This study analysed domiciliary midwifery support in high-risk pregnancy incorporating telephonic fetal heart rate monitoring (randomized trial). They used the societal perspective, including all relevant costs that varied between the studies. It was demonstrated that substituting conventional visits with midwifery visits, including telehealth, saved 223.83 UK Pounds. This was due mainly to decreased antenatal visits and inpatient care, and decreased lost working time of the women and their partners. Telehealth was recommended.
Economic quality score: 7

Doolittle, 2000. In this study the costs of tele-hospice and conventional home-based hospice service were compared. The study concentrated on hospice service related costs only, excluding possible costs to patients and their families. In two three-month periods the cost of conventional hospice service were US$126 and US$146 per visit, respectively. During the second three-month period tele-hospice services were also provided, and they cost US$29 per visit. The US Medicare reimbursement rate was US$100 per day in hospice care. The study concluded that tele-hospice services may increase the efficiency of hospice services, especially in rural areas where nurses have to travel long distances to see patients. By replacing at least part of the services with tele-hospice services, they can provide more services or see patients more frequently. Further research is needed to define clearly the role of tele-hospice service in Canadian health care system. (Study also included in rural / remote telehealth section.)
Economic quality score: 4

Johnston et al, 2000. This randomized tele-homecare study used videoconferencing visits and gave homecare patients access to a home health care nurse 24 hours a day in addition to conventional homecare services. The control group got the same conventional services as before. Quality of care and patient satisfaction were good. Telecare was more expensive than conventional care (USD1830 vs. USD1167 respectively), but the other health care costs were lower in the telehealth group compared to the control group (US$1948 vs. US$2674, respectively). Tele-homecare can be an asset for patients and providers.
Economic quality score: 4

Subirana Serrate et al, 2001. This cost-minimization analysis of oncology patients looked at two groups: those who were hospitalized at home when possible and had access to 24 hours telephone support, versus those who received hospital care. All direct variable medical care costs were provided by health insurance companies (health care perspective). The total home care cost was 64% of that of hospital care (difference not significant). The cost minimization analysis showed significant cost savings for oncology patients nursed at home with telephone support. Telephone-supported homecare was recommended. (Study also included in Geriatrics telehealth section.)
Economic quality score: 4

Summary of tele-homecare studies

The studies in tele-homecare involved several different patient groups (e.g., diabetic patients, oncology patients). They all introduced a new telemedicine service to replace either patients' hospital visits or the homecare visits of health care staff. The economic analysis showed that telehealth applications are as costly or cheaper than conventional alternatives. Only one of the studies used the societal perspective in the analysis, which indicates that some analyses may be underestimating the real societal costs and savings of these alternatives. The economic quality score values of the studies were moderate or good.

Although there is evidence that tele-homecare services can be cost-saving, more studies in the field are needed to confirm these results in Canada and Alberta.

Tele-mental health

Elford et al, 2001. The study evaluated the costs of telepsychiatry services and conventional alternatives where a child and his parents traveled to psychiatric consultation in St John's (670 km). However, parents' lost working time and other domestic costs were not included in the study. This pilot study found that the telehealth alternative was cost-saving as compared to the conventional alternative, only when ten or more patients per month were consulted. If nine patients per month were consulted, then the conventional alternative became more economical. Although the cost analysis is not complete, it demonstrates the importance of including patients'/families' travel and hotel costs when patients are coming from remote places.
Economic quality score: 4

Mielonen et al, 2000. In this Finnish study, patient care planning negotiations were made using videoconferencing between the patient's home community health center and University Hospital where the patients were in the ward. The study showed that telepsychiatry can be cost-saving on relatively low patient workloads (less than 30 patient per year). The study used a societal perspective. Some of the meetings would not have been possible to arrange without telehealth because of the consequence of lost working for health care staff in the conventional alternative.
Economic quality score: 6

Schopp et al, 2000. In this study, 49 neuropsychology patients were interviewed using videoconferencing and 49 matched controls had face-to-face neuropsychological

assessment. Telehealth clients were more likely to want to repeat their experience. Calculating mainly the psychiatrist and patient travel cost, they concluded that the telehealth alternative was significantly less expensive than in-person consultation costs (either in university hospital or outreach). Videoconferencing costs were not specified in any detail.
Economic quality score: 3

Simon et al, 2000. The aim of this randomized study was to assess whether feedback to physicians or feedback plus telephone care by case managers improve outcomes in patients treated for depression. The authors constructed a cost analysis of the alternatives using health care and patient costs. They found that the incremental cost of feedback plus care management by telephone was US$85 per patient.
Economic quality score: 6

Simpson et al, 2001 (a,b); Doze et al, 1997, 1999. This Alberta project analyzed telepsychiatry services from both the provider and patient perspectives. The cost analysis showed that, compared to travelling to larger centres, telepsychiatry become cost-saving after 348 consultations per year. If the use of the videoconferencing equipment for administrative purposes is included in the calculations, the break-even point was 224 consultations per year. The calculation of patient costs showed that patients had significant savings from the use of telemedicine due to decreased travel and child care costs, and lost working time. Telehealth is likely to be beneficial from the societal perspective even in workloads lower than 224 consultations per year.
Economic quality score from articles altogether: 7

Tang et al, 2001. The study examines the use of telepsychiatry in psychogeriatric service. Psychogeriatric services were provided via videoconferencing in the city of Hong Kong for 149 patients. The cost analysis used a health care perspective and it showed that even within the city area the telehealth alternative was 13.2% cheaper than conventional care where the psychiatrist travelled to the consultation. The main reason for the low cost of telehealth was that the same equipment was used for other geriatric services, so the share of costs allocated to psychiatry was small.
Economic quality score: 5

Trott and Blignault, 1998. In this study a brief cost comparison was made for telepsychiatric services between an isolated Australian mining town and regional centre (distance 900 km). The savings to health authorities were estimated to be AU$85,380 in the first year, and AU$112,790 in subsequent years due to the high travel costs of the patients and psychiatrists. In addition, they estimated to have AU$96,336 annual savings in the emergency flights (27 patients). The study showed considerable savings from reduced travel by patients and health care workers. (This study also included in rural/remote telehealth section.)
Economic quality score: 2

Summary of tele-mental health studies
In most cases, there were cost savings associated with the tele-mental health applications. In instances where the patients (and their caregivers) or health care professionals have to travel long distances for services, the break-even point where the telehealth alternative becomes cost-saving can be relatively low. In some cases telepsychiatry is the only

feasible/economical way of delivering mental health services to rural and remote places. The inclusion of patients' and caregivers' travel costs is important in decision-making, since specialized psychiatric services (e.g., in Paediatrics) are generally only available in big cities.

The quality of the economic studies ranged between 2 and 7 on the Drummond scale; however, in general, the economic quality of the studies in tele-mental health was among the highest of all the subject areas in this review. Many of the study results are applicable to the Alberta health care environment.

Teleradiology

Bailes et al, 1997. The study estimates cost savings of a wide-area telehealth network for neurological consultations in the US (Pittsburgh area). They prospectively reviewed 100 consecutive neurosurgical teleconsultations. Thirty-three patients avoided transportation to tertiary hospital due to teleconsultations. It was estimated that US$502,638 was saved in hospitalization and transportation costs (health care system perspective). The study concluded that the telehealth has led to more appropriate transfer of patients to the tertiary facility as well as significant estimated cost savings. (Study also reviewed in rural/remote telehealth section.)
Economic quality score: 1

Bergmo, 1996. The study examines the economic analysis of teleradiology versus a visiting service. It showed that the teleradiology service (6000 patients) between the local hospital without radiologist and University Hospital cost NKr108 per patient, while the cost for a visiting radiologist service was NKr178 per patient. Teleradiology becomes cheaper after the workload exceeded 1576 patient per year. If a shorter lifetime of the teleradiology unit were assumed (four years instead of six years), the threshold value would increase to 2320 patients per year. This study uses the health care system perspective.
Economic quality score: 8

Bracale et al, 2002. This article deals with telehealth services for two islands in the Bay of Naples. Most of the patients were radiology patients. The study used a health care provider perspective in its analysis. The fixed costs of the system were EUR 48,000 per year and the variable costs were EUR 750 per year. The total savings due to telehealth service was EUR 40,000 per year. Therefore there was little difference in the overall cost of health care delivery. The authors recommend telehealth for isolated islands; however, the strength of the study results is weak.
Economic quality score: 2

Brumage et al (2001) examine the use of teleradiology in a US military training area (Hawaii). Their cost calculations showed that during the first one-year period the estimated savings would be US$176,540 and the cost of teleradiology was US$167,203. Over five years the costs and savings were estimated to be US$349,940 and US$882,700, respectively. The study was relatively well conducted, but the perspective of the study is military medicine, so it cannot be directly applied to other health care systems.
Economic quality score: 8

Davis 1997. This study is an economic analysis of teleradiology systems in private rural imaging centers that analyzed MRI images. At an expected case-load of 200 per year, a mid-field MR unit was predicted to cost US$470 per case using teleradiology, and US$ 544 per case using film and a courier service (health system perspective).
Economic quality score: 4

Halvorsen & Sonbo Kristiansen, 1996, 1997. The study is a cost-minimization model that compared three alternatives. The existing system (small x-ray unit at the remote site) was compared with all other examinations at the nearest radiology department, teleradiological services, and visiting specialist services. After excluding costs common to all three alternatives, the direct medical, direct non-medical (travel) and production lost costs for these alternatives were (in pounds) 91,500,123,500, and 117,00 for the alternatives, respectively. Sensitivity analysis showed that the existing system was the least costly option with the exception of when lost leisure time is valued as lost production. The study takes the perspective of both the health care provider and society. The data is fairly old (1993), so may not be applicable today.
Economic quality score value: 8

Maas et al, 2000. This study compares the transportation savings and medical benefits of a tele-neurological network between Turku University Hospital in Finland and three regional hospitals. From 83 teleconsultation patients, 81% of them avoided unnecessary transportation and saved overall EUR 42,100. Consulting digital CT scanner (and MRI scanner) images between hospitals can be cost-saving since the system doesn't require high investment costs.
Economic quality score of the study: 2

Stoeger et al, 1997. The cost analysis of an emergency CT teleradiology system between a regional hospital and University Hospital in Innsbruck, Switzerland, is examined. Using ISDN connections, the average cost of one emergency CT examination by teleradiology was DM372 (range 308-453). Using a slower taxi transportation would cost DM156. Transportation of the patient to the nearest central hospital was more expensive: DM524 by road or DM4667 by helicopter ambulance. The authors recommend the implementation of an emergency CT service in the remote hospital, because it offers benefits to emergency patients and cost-efficient operation is possible.
Economic quality score: 4

Walz et al, 1999. The study examined a teleradiology system in Germany that transferred CT examinations via ISDN lines. Videoconferencing was used to contact the on-duty radiologist. From the two scenarios calculated in the study, teleconsultation began to be cost-saving for health care system after 1817 patients, or 528 patients per year. The system was seen to be expensive under current conditions, and cost-saving only under the most favourable conditions in the cost analysis (health care system perspective). This study is not considered to be applicable to Alberta.
Economic quality score value: 6

Summary of teleradiology studies

The studies in teleradiology show that cost savings do occur in several different areas of application. The most convincing evidence is found in teleneurology / teleneurosurgery, involving the transmission of CT and MR images. In some settings, cost savings do occur when transmitting x-ray images, if workload and distances are great enough. The studies show cost savings both in the consultations between primary and secondary care and between specialty consultations. The cost analysis was primarily from the perspective of the health care sector. The economic quality of the studies ranged from 1 to 8. It is likely that there are some teleradiology applications that are economically feasible in Alberta.

Tele-ultrasound

Malone et al, 1998. This study analyzed the costs of the use of computerized telemedicine for obstetric ultrasonography. This US-based study included a network of one specialized tertiary level clinic and three local physicians' offices with a monthly workload of 600 obstetric ultrasound examinations. The real-time video-based telehealth alternative proved to be an economically sustainable solution when compared to couriering the recorded ultrasound examination to a specialized clinic (distances not specified). Telehealth alternatives saved in the printing of the images to paper, couriering costs and in repeated examinations due to low-quality images on tape. The study included only main health care costs (ignoring, for example, patients' travel and lost work time due to extra examinations in conventional care). For the health care provider, the telehealth system paid the investment cost back in 12 to 14 months. Because the direct electronic communication also reduces the use of secretarial work (cost not included in the study), the current estimates probably overstate the actual pay-back time of the investment. (This study also included in rural/remote telehealth section.)
Economic quality score: 5

Summary of tele-ultrasound studies

Only one economic study from ultrasound was found in the search. The transmission of ultrasound images utilizes videoconferencing technology. This means that the incremental cost of sending ultrasound images is not high, especially if one or both sites already have videoconferencing equipment. The study by Malone et al (1998) included a telemedicine network of obstetric services with a relatively high frequency of examinations per month (200 per site). With a lower patient volume the pay-back time of the investment would be longer. If conventional services are provided by visiting a specialist, the high travelling costs may make the telemedicine alternative cost-saving given a relatively low number of examinations per year; however, there was no cost calculation of this alternative.

Renal dialysis

The review did not find any good economic studies related to renal dialysis. Telehealth applications in renal dialysis are mostly videoconferencing connections between satellite clinics and university clinics. The connections are used to supervise and monitor the care

given in the satellite clinics, and to give specialized care consultations to satellite care patients in specific renal dialysis related conditions. There are also telehealth applications in home dialysis care, although they do not include proper economic analysis. The economic issues around renal dialysis cooperation via telehealth are significant, since patients require treatment several times per week. Problems in care may lead to substantial additional costs in ambulatory care with ambulance transportations and hospitalizations. More analysis is needed in the area to demonstrate cost-effective methods of maintaining high quality renal dialysis care in remote and rural satellite units and home dialysis.

Rural/Remote Telehealth

Agha et al (2000) conducted a cost-minimization analysis of telehealth for delivery of pulmonary outpatient care to a rural site in the US. This abstract shows that the telehealth outpatient consultation was cost-saving compared to patients' visit at the rural hospital (including 450 mile round-trip, lost productivity and one hotel night). The annual costs were US$441 per patient manager by telehealth and US$540 per conventional care patient (societal perspective). From a health care provider perspective the telehealth alternative was US$37 more expensive than outpatient clinic visit. The authors concluded that telehealth is a cost-effective way of delivering pulmonary outpatient care to a remote area with limited access to care.
Economic quality level: 4

Bailes et al, 1997. The study estimates cost savings of a wide-area telehealth network for neurological consultations in the US (Pittsburgh area). They prospectively reviewed 100 consecutive neurosurgical teleconsultations. Thirty-three patients avoided transportation to tertiary hospital due to teleconsultations. It was estimated that US$502,638 was saved in hospitalization and transportation costs (health care system perspective). The study concluded that the telehealth has led to more appropriate transfer of patients to the tertiary facility as well as significant estimated cost savings. (This study also reviewed in teleradiology section.)
Economic quality score: 1

Bergmo, 1997. An economic analysis of teleconsultations in otorhinolaryngology in Northern Norway showed that telehealth was cost-saving as compared to conventional patient visits to the University Hospital (distance 400 km). The cost savings occurred after 56 patients per year, and visiting ENT specialist service began to be cost-saving over telehealth after 325 patients per year. If the primary care doctor learning effect during the video-consultations was taken into consideration, telehealth began to be cost saving after 52 patients per year.
Economic quality score: 7

Bergmo, 2000. The study shows results of a cost-minimization analysis of real-time teledermatology services in northern Norway. The costs of teledermatology when using videoconferencing were compared to three alternatives.
1. specialist visits a health centre and patient travels to hospital for treatment,
2. patient travels to the nearest secondary care centre,
3. locally employed dermatologist.

At the 1998 workload of 375 patients, the total cost of teledermatology was NKR470,780 while the three alternatives cost NKR880,530, NKR1,635,075 and NKR958,660, respectively. Break-even analysis showed that real-time teledermatology, including local phototherapy, was less costly than the three alternatives for annual number of patients over 195. Sensitivity analysis showed that the results were robust to changes in cost variables. In summary, real-time teledermatology can be cost-saving and it can enable wider local dermatological care in the supervision of dermatologists.
Economic quality score: 8

Della Mea et al, 2000. This short economic study compares the costs of telepathology services in a mountain hospital to three conventional alternatives: visiting pathologist, ambulance transfer of frozen section to main hospital, and service of own pathologist. Ambulance service is cost saving up to 73 patients per year; however, the prolonged operation times may increase the costs of this alternative. Telepathology is least costly after 73 patients per year. The analysis was done from a health care sector perspective. The study did not include most of the important details of cost analysis, hence the validity and reliability of the study results cannot be guaranteed.
Economic quality score: 1

Doolittle et al, 1997. This cost analysis compares a tele-oncology practice to fly-in specialist outreach services to rural hospital in the US. The data is somewhat dated (May 1995 – April 1996). The results show that during the one-year period 184 patients were seen (56% tele-oncology and 44% outreach). The health care cost of telecare was US$ 812 and outreach clinic visit US$897. If the patient had visited the university hospital, the clinic cost without traveling costs would have been US$149. The study summarizes that the costs of telehealth alternatives were only 10% lower than fly-in outreach consultations. The new practice provides the oncology services to many patients that would not otherwise have received specialist services.
Economic quality score: 4

Doolittle, 2000. In this study the costs of tele-hospice and conventional home-based hospice service were compared. The study concentrated on hospice service related costs only, excluding possible costs to patients and their families. In two three-month periods the cost of conventional hospice service were US$126 and US$146 per visit, respectively. During the second three-month period tele-hospice services were also provided, and they cost US$29 per visit. The US Medicare reimbursement rate was US$100 per day in hospice care. The study concluded that tele-hospice services may increase the efficiency of hospice services, especially in rural areas where nurses have to travel long distances to see patients. By replacing at least part of the services with tele-hospice services, they can provide more services or see patients more frequently. Further research is needed to define clearly the role of tele-hospice service in Canadian health care system. (This study also included in tele-homecare section.)
Economic quality score: 4

Malone et al, 1998. This study analyzed the costs of the use of computerized telemedicine for obstetric ultrasonography. This US-based study included a network of one specialized tertiary level clinic and three local physicians' offices with a monthly workload of 600 obstetric ultrasound examinations. The real-time video-based telehealth alternative proved to be an economically sustainable solution when compared to

couriering the recorded ultrasound examination to a specialized clinic (distances not specified). Telehealth alternatives saved in the printing of the images to paper, couriering costs and in repeated examinations due to low-quality images on tape. The study included only main health care costs (ignoring, for example, patients' travel and lost work time due to extra examinations in conventional care). For the health care provider, the telehealth system paid the investment cost back in 12 to 14 months. Because the direct electronic communication also reduces the use of secretarial work (cost not included in the study), the current estimates probably overstate the actual pay-back time of the investment. (This study also included in tele-ultrasound section.)
Economic quality score: 5

Massman et al, 1999. The regional Hospital Burn Centre completed 87 follow-up visits with 40 patients via videoconferencing. Patients were seen in 15 sites in six US states. Teleconsultations saved patients money but were more time consuming for the physician and therapist. Remote sites became more efficient in presenting their patients during the program. The program increased access for rural patients and their doctors to specialist burn consultations and improved the regional network.
Economic quality score: 1

Pringle Specht et al, 2001. The article is a cost-minimization analysis of a pilot telemedicine chronic wound consultation clinic, from the point of view of gerontological nursing. The perspective of the study was mainly that of the health care system, although some patient costs were discussed. The average cost of a telehealth chronic wound consultation was US$136.16 versus US$246.38 for face-to-face consultation, including patient transportation. The opportunity cost of lost working time in the option where specialized nurse travels to see the patient was high (12 patient consultations missed). Telehealth cost savings are demonstrated. (This study also included in geriatric telehealth section.)
Economic quality score: 5

Trott and Blignault, 1998. In this study a brief cost comparison was made for telepsychiatric services between an isolated Australian mining town and regional center (distance 900 km). The savings to health authorities were estimated to be AU$85,380 in the first year, and AU$112,790 in subsequent years due to the high travel costs of the patients and psychiatrists. In addition, they estimated to have AU$96,336 annual savings in the emergency flights (27 patients). The study showed considerable savings from reduced travel by patients and health care workers. (This study also included in tele-mental health section.)
Economic quality score: 2

Summary of rural/remote telehealth studies

Rural and remote telehealth applications involve several different specialty areas that utilize different technologies, hence they are difficult to compare and summarize. Generally, the studies showed that it is economically feasible and in most cases cost effective to use telehealth in rural/remote consultations. However, that conclusion cannot be applied to all rural sites and to all specialties in Alberta and northern territories, since some of the studies involved considerably greater volumes of patients than are present in parts of rural or northern Alberta. If health care provider costs only are included, the

telehealth alternative is not always cost-saving. However, if patients' travel and lost working time are included, many of the telehealth alternatives become cost-saving from a societal perspective. In addition, it is very difficult to measure the value of increased access to care, equity in health, and the value of health care staff education during consultations to remote and rural areas.

The quality of economic studies in the field varied greatly (between 1 and 8). More economic studies are needed that are specially connected to the rural/remote environment in Canada and Alberta since there may be some variation as compared with the US or UK environments.

Tele-rehabilitation

The review did not identify any economic studies related to rehabilitation. The volume of telehealth applications in rehabilitation is increasing in Canada and elsewhere, hence there is an urgent need for economic assessment in this field.

VI RECOMMENDATIONS AND CONCLUSIONS

General recommendations arising from this study are:

A. Policy

1. To be successful and sustainable, telehealth must be fully integrated into existing health structures and processes in a practical and policy manner.

2. Integration can be achieved through aligning telehealth initiatives with existing strategic health plans, policy goal-setting, accompanying action steps, and resolution of policy barriers.

3. Establishment of a policy forum that focuses on telehealth policy would facilitate these needs.

4. Telehealth applications should incorporate capacity for education, research, and administrative functions, as well as health and clinical functions.

5. Federal-provincial/territorial partnerships in telehealth should be established where there are opportunities to improve efficiency in health care and decrease duplication.

6. As telehealth continues to evolve, input from all key stakeholders (including patients, health care providers, and the public) into policy development is required. Consideration of needs as well as practical experience is essential for a meaningful exchange of information and views.

7. Consistent terminology and definitions around telehealth, e-health and related terms should be adopted across jurisdictions.

B. Technology

8. To facilitate access to many bandwidth intensive telehealth applications increased broadband connectivity is needed, particularly to rural and remote communities.

9. Given the evidence, the use of telephone-based telehealth applications should be re-examined.

10. Technology modalities (broadband, narrowband, web-based) and applications (videoconferencing, data monitoring, telephone) should be viewed as synergistic, not competitive, and the most appropriate tool applied; i.e., hybrid connectivity solutions are recommended.

C. Evaluation

11. Suitable outcome indicators, measures, and reliable and valid instruments for socio-economic benefit of telehealth must be identified, defined, and

consistently applied within a recognized evaluation framework that asks relevant research questions.

12. Suitable frameworks for economic analysis need to be developed that capture non-monetary and unintended consequences, as well as monetary measures.

13. Telehealth programs should be implemented and evaluated in a culturally aware and culturally sensitive manner.

14. Evaluations should include examination of the social, organizational, and policy aspects of telehealth.

D. Economic

15. Telehealth demonstrates sufficient evidence of socio-economic benefit to indicate ongoing investment is appropriate.

16. Sustainable telehealth 'programs' and not 'projects' should be targeted.

17. Full integration of telehealth will increase its use and decrease the per contact episode cost.

18. Investment in information and communications technology infostructure should be considered as an investment not only in health, but in business, education, and other e-sectors.

E. Investment Opportunities

19. R & D and economic development opportunities require pursuit.

Subject-specific recommendations arising from this study are as follows:

Paediatric Telehealth

20. Telehealth programs that improve quality of care and offer economic benefit for 'at risk' paediatric populations (e.g., neonates, adolescent asthmatics) should be introduced.

21. Telehealth programs that improve quality of care and offer economic benefit for 'at risk' paediatric populations (e.g., neonates, adolescent asthmatics) should be introduced.

22. Evidence would suggest decision makers should consider telehealth to achieve enhanced social environments for children, and staff efficiencies as related to data transfer.

23. The use of low-cost technology solutions (e.g., the telephone) is strongly recommended for Paediatric telehealth where appropriate.

Geriatric Telehealth

24. Telehealth programs should be used to support palliative home care initiatives.

25. Remote, wireless monitoring (e.g., personal alerts, caregiver and patient support, 'smart' homes and clothing) should be investigated for both enhanced independent living and geriatric healthcare applications.

26. Geriatric telehealth applications should be strongly considered as a technology R & D and economic development opportunity.

27. The use of e-prescription applications should be used to increase self-efficacy and compliance, and to reduce adverse effects.

28. The use of low-cost technology solutions (e.g., the telephone) is strongly recommended for Geriatric telehealth where appropriate.

First Nations Telehealth

29. The recommendations provided in the Health Transition Fund project report of 2001 (Health Canada) should be implemented, viz:

    - Increase connectivity to rural and remote communities, and especially Aboriginal communities;

    - Undertake new research further to implementation of successful telehealth initiatives in First Nations and Inuit communities, and regarding the impact of telehealth on costs, health services and human resources;

    - Promote equality of opportunity for telehealth across First Nations and Inuit communities;

    - Increase awareness and understanding of telehealth opportunities among First Nations and Inuit stakeholders;

    - Create linkages between telehealth and other initiatives of the Aboriginal Health Infostructure in order to leverage investments.

30. Health services and information content should be delivered in a culturally sensitive context.

Tele-homecare

31. Telehealth should be considered for application in managing and monitoring chronic heart failure, chronic obstructive pulmonary disease, oncology, diabetes, wound care, asthma, anxiety, and cardiovascular accident.

32. Home Telehealth programs should be used to assist with and transform the mode of delivery of home care. Such programs should be used to support change within the context of the continuum of care, and a comprehensive home healthcare program.

Tele-mental health

33. Tele-mental health, a proven and sustainable telehealth application, should be expanded.

34. The use of low-cost technology solutions (e.g., the telephone) is strongly recommended for tele-mental health where appropriate.

Teleradiology

35. Teleradiology, a proven and sustainable telehealth application in settings of appropriate workload and distance, should be expanded.

36. Teleradiology should be adopted in settings where the need to travel or poor speed of care provision present barriers to access.

Renal Dialysis Telehealth

37. Teledialysis should be evaluated more comprehensively before commitment is made.

Rural and Remote Telehealth

38. Increased access to a broad range of clinical and educational resources should be provided to rural, remote, and underserved populations.

39. Enhanced connectivity to rural and remote communities and residences should be a priority to improve economies of scale in future service and information delivery.

Telerehabilitation

40. Telerehabilitation, which has been demonstrated to show benefits for health care and patients (e.g., speech pathology, transtelephonic exercise monitoring) requires more comprehensive economic analysis.

VII SUMMARY

This review study has identified many telehealth applications in a variety of subject areas that have proven socio-economic benefit to patients, providers, the health care system and society as a whole. Certainly many of these telehealth programs can be seen as applicable to the Canadian and Alberta environments, and these have been identified in the chapters. The nine socio-economic areas of benefit that were referenced most often in the literature were access to care and services, costs or cost-effectiveness, education, support, social isolation, patient/provider satisfaction, health outcomes, quality of care and quality of life. Table S.1 provides a count of studies within each subject area which provided good to fair scientific evidence for the benefit of telehealth as compared with conventional care.

Table S.1 Areas of Benefit of Telehealth Applications

Areas of Benefit:		1	2	3	4	5	6	7	8	9
Subject Area	*Number of studies providing Good to Fair evidence**	*Access*	*Cost / CE / Decreased health services utilization*	*Education*	*Support*	*Social Isolation*	*Acceptability / Satisfaction*	*Health Outcomes*	*Quality of Care*	*Quality of Life*
Geriatrics	16	8	6	3	4		6	3	2	
Paediatrics	24	3	9	1	3	1	2		3	3
First Nations	2			1						1
Telerehabilitation	5		2	1			2		1	3
Tele-Mental Health	16	2	2	3	3	1	2		3	1
Teleradiology	30	10	15					1	3	
Rural / Remote	7		1	1			4		1	1
Tele-Homecare	9	1	6				4		2	2
Renal	0									
Systematic Reviews	17	3	4				4	4	2	

* Note: this denotes the number of studies within each subject area which demonstrated Good to Fair scientific evidence based on the 1995 Jovell/Navarro-Rubio rating scale – a 5 point scale including the ratings: Good, Good-Fair, Fair, Fair-Poor, Poor (Hailey et al, 2002).

Table S.2 summarizes the various benefits to health system stakeholders as suggested in the literature.

Table 2 Summary of the socio-economic impact of telehealth on stakeholder groups

Patients and Families • Increased access to services • Personal cost savings, i.e., time and travel expense through substitution of telehealth for face-to-face treatment • Improved or equivalent clinical and/or functional health outcomes and quality of care (as compared with traditional care) • Increased empowerment, patient involvement and participation in care, positive perception, satisfaction • Enhanced self-care skills and potential for patients to live independently in their own homes, particularly for elderly and disabled persons • Quality of life benefits, including reduced life stress, improved access to information, social and emotional support, and reduced social isolation • Education	**Providers** • Improved efficiency in work – If it is the provider that travels to provide care to remote patients (e.g., satellite clinics), then telehealth can result in travel time savings and providers are able to see more patients. – If it is the patient that travels to a central site to receive services, then telehealth, which may represent increased convenience for patients, can have a positive impact on no-show rates. • Improved access to professional/specialty support, particularly for rural/remote providers, and associated with this: reduced social isolation and enhanced skills • Increased access to educational opportunities and skills development
Programs • Improved cost-effectiveness of health programs delivered to specific populations. • Reduced costs of direct care, medication costs, etc.	**Regional Health Authorities / health organizations** • Cost-effectiveness, through, for example – reduced utilization of health services (i.e., reduced hospitalization rates, reduced utilization of outpatient services, emergency services) – reduced costs of patient transport from remote locations – reduced costs of service delivery • Alignment with strategic policy; for example: in accordance with patients' preferences, enhancing their ability to live independently and stay in their homes as long as possible
The Public • Retention of health services professionals; sustainability of health services in smaller, rural/remote communities; economic viability • Increased choice / more options in health care • Enhanced prevention and health promotion initiatives which can be offered via telehealth feasibly and cost-effectively	**At the provincial and national levels** • Positive impact on health human resources recruitment and retention • Alignment with current policy and strategic initiatives, including – support for primary care – new, innovative ways of delivering health services – prevention / health promotion – complementary to electronic health record (EHR) development and implementation

There are certain telehealth applications that have proven significant socio-economic benefit. In the Telehealth Reviews chapter, systematic reviews by Hailey et al (2002) and Roine et al (2001) found the most evidence of efficacy and efficiency for telehealth in the following areas of application: teleradiology (i.e., CT transmission), tele-mental health, ECG transmission, teledermatology, tele-homecare and some medical consults. Hersh et al (2001) found that videoconferencing, self-monitoring and store-and-forward technologies can improve access to care, quality of care, and/or clinical outcomes, in their review studies of Paediatric, Obstetric and home telehealth studies.

The most evidence for economic efficiencies, outlined in the Economic Analysis chapter, was in the areas of home telehealth, tele-mental health, teleradiology, and rural and remote telehealth. Examples of proven economic applications include:

- Videoconferencing between a tertiary site and a remote health centre/clinic, nursing home, or private home;
- Telephone-based assessment, care, and/or follow-up, sometimes supplemented by technologies such as decision support;
- High-speed data transmission; i.e.: radiological images, echocardiograms, or other patient data.

However, the study did not find any consistency in identification or application of social or economic indicators within, or between, studies in any subject area. This finding highlights a critical gap in our current research process and capabilities. In order to better define key areas of socio-economic benefit for further study, policy makers need to be engaged and, importantly, so does the public as a whole. Resources can then be directed to initiatives where telehealth can have the greatest impact on the health and well-being of the population.

Given the evidence that exists, specific, program area recommendations are provided regarding key directions for telehealth in Alberta and Canada. However, sound evaluation of new initiatives must be a component of any project, and avenues must be opened so that innovative solutions can be tested. Therefore, general recommendations pertaining to policy, technology, evaluation, and economic analysis are also provided in this study.

Given today's information and communications technology and telecommunications environment, there is significant potential for the expansion of telehealth and realization of substantial benefits to patients and all stakeholders in the health care system within the next decade.

VIII REFERENCES

Ades, P. A., Pashkow, F. J., Fletcher, G., Pina, I. L., Zohman, L. R., & Nestor, J. R. (2000). A controlled trial of cardiac rehabilitation in the home setting using electrocardiographic and voice transtelephonic monitoring. *Am Heart J, 139,* 543-548.

Agha, Z., Schapira, R.M., Varkey, B., Frahm, J.A., Dunn, D.E. (2000) Telemedicine for delivery of pulmonary outpatient care to a rural site: A cost analysis. *Journal of General Internal Medicine, 15, Suppl. 1*, 97.

Ames, D. (1992). Psychiatric diagnoses made by the AGECAT system in residents of local authority homes for the elderly: Outcome and diagnostic stability after four years. *International Journal of Geriatric Psychiatry, 7,* 83-87.

Anderson, J. L., Gilbert, E. M., Alpert, B. L., Henthorn, R. W., Waldo, A. L., Bhandari, A. K. et al. (1989). Prevention of symptomatic recurrences of paroxysmal atrial fibrillation in patients initially tolerating antiarrhythmic therapy. A multicenter, double-blind, crossover study of flecainide and placebo with transtelephonic monitoring. *Circulation, 80,* 1557-1570.

Artinian, N. T., Washington, O. G., & Templin, T. N. (2001). Effects of home telemonitoring and community-based monitoring on blood pressure control in urban African Americans: a pilot study. *Heart Lung, 30,* 191-199.

Artunian, J. (1998). Rehab gets wired... telemedicine rehab services. *Rehab Management: The Interdisciplinary Journal of Rehabilitation, 10,* 54.

Baer, L., Elford, D. R., & Cukor, P. (1997). Telepsychiatry at forty: what have we learned? *Harv.Rev.Psychiatry, 5,* 7-17.

Bailes, J. E., Poole, C. C., Hutchison, W., Maroon, J. C., & Fukushima, T. (1997). Utilization and cost savings of a wide-area computer network for neurosurgical consultation. *Telemed.J, 3,* 135-139.

Balas, E. A., Jaffrey, F., Kuperman, G. J., Austin, B. S., Brown, G. D., Pinciroli, F. et al. (1997). Electronic communication with patients: evaluation of distance medicine technology. *JAMA, 278,* 152-159.

Ball, C. & McLaren, P. (1997). The tele-assessment of cognitive state: a review. *J Telemed.Telecare, 3,* 126-131.

Barbaro, V., Bartolini, P., & Bernarducci, R. (1997). A portable unit for remote monitoring of pacemaker patients. *J Telemed.Telecare, 3,* 96-102.

Barber, J. W., King, W. D., Monroe, K. W., & Nichols, M. H. (2000). Evaluation of emergency department referrals by telephone triage. *Pediatrics, 105,* 819-821.

Bates, J., Gilat, L., Johnson, J., MacKay, M., Yun, G. W., Lear, S. et al. (2002). Utilization and Impact of an Internet-Based Cardiac Rehabilitation Program by Rural Patients with Coronary Artery Disease. Ref Type: Unpublished Work

Bates, J., Gilat, L., Johnson, J., MacKay, M., Lear, S., & Johnson, P. (2002). Outcomes of a web-based cardiac rehabilitation program delivered to patients living in rural and regional centres. Ref Type: Unpublished Work.

Battles, H. B. & Weiner, L. S. (2002). Starbright World: Effects of an electronic network on the social environment of children with life-threatening illnesses. Children's Heath Care March 1, 31[1], 47-68.

Beck, R. D., Saddler, C., & Ranch, R. (1998). Preliminary experience with an orthopedic teleradiology service at the Alaska Native Medical Center. *Int J Circumpolar.Health, 57 Suppl 1,* 689-690.

Benger, J. (1999). A review of minor injuries telemedicine. Journal of Telemedicine and Telecare Aug 5[suppl 3], 5-13.

Bergmo, T. S. (1996). An economic analysis of teleradiology versus a visiting radiologist service. *J Telemed.Telecare, 2,* 136-142.

Bergmo, T.S. (1997). An economic analysis of teleconsultation in otorhinolaryngology. *J Telemed Telecare, 3(4)*, 194-199.

Bergmo, T.S. (2000). A cost-minimization analysis of a realtime teledermatology service in northern Norway. *J Telemed Telecare, 6(5)*, 273-277.

Berkman, P., Heinik, J., Rosenthal, M., & Burke, M. (1999). Supportive telephone outreach as an interventional strategy for elderly patients in a period of crisis. *Social Work in Health Care, 28,* 63-76.

Biermann, E., Dietrich, W., & Standl, E. (2000). Telecare of diabetic patients with intensified insulin therapy. A randomized clinical trial. *Studies in Health Technology & Informatics, 77,* 327-332.

Boland, G. W. (1998). Teleradiology: another revolution in radiology? *Clin.Radiol., 53,* 547-553.

Bondmass, M., Bolger, N., Castro, G., & Avitall, B. (1999). The effect of physiologic home monitoring and telemanagement on chronic heart failure outcomes. *Internet Journal of Advanced Nursing Practice, 3,* 17 pages.

Bondmass, M., Bolger, N., Castro, G., & Avitall, B. (2000). The effect of home monitoring and telemanagement on blood pressure control among African Americans. *Telemedicine Journal, 6,* 15-23.

Boulanger, B., Kearney, P., Ochoa, J., Tsuei, B., & Sands, F. (2001). Telemedicine: a solution to the follow up of rural trauma patients? *J Am Coll Surg, 192,* 447-452.

Bracale, M., Cesarelli, M., & Bifulco, P. (2002). Telemedicine services for two islands in the Bay of Naples. *J Telemed.Telecare, 8,* 5-10.

Brennan, P. F. & Moore, S. M. (1994). Networks for home care support: the ComputerLink project. *Caring, 8,* 64-66.

Britton, B.P., Engelke, M.K., Rains, D.B., Mahmud, K. (2000). Measuring costs and quality of telehomecare. *Home Health Care Management & Practice, 12(4),* 27-32.

Brumage, M. R., Chinn, S., & Cho, K. (2001). Teleradiology in a military training area. *J Telemed.Telecare, 7,* 348-352.

Burns, R. B., Crislip, D., Daviou, P., Temkin, A., Vesmarovich, S., Anshutz, J. et al. (1998). Using telerehabilitation to support assistive technology. *Assist Technol, 10,* 126-133.

Bynum, A., Hopkins, D., Thomas, A., Copeland, N., & Irwin, C. (2001). The effect of telepharmacy counseling on metered-dose inhaler technique among adolescents with asthma in rural Arkansas. *Telemed.J E Health, 7,* 207-217.

Cameron, K., Hughes, K., & Doughty, K. (1997). Reducing fall incidence in community elders by telecare using predictive systems. *Proceedings of the 19th IEEE Engineering in Medicine and Biology Society Conference, 3,* 1036-1039.

Campbell, J. D., Harris, K. D., & Hodge, R. (2001). Introducing telemedicine technology to rural physicians and settings. *J Fam.Pract., 50,* 419-424.

Campbell, N. D., Ritchie, L. D., Cassidy, J., & Little, J. (1999). Systematic review of cancer treatment programmes in remote and rural areas. *British Journal of Cancer, 80,* 1275-1280.

Capner, M. (2000). Videoconferencing in the provision of psychological services at a distance. *J Telemed.Telecare, 6,* 311-319.

Carroll, D. L., Robinson, E., Buselli, E., Berry, D., & Rankin, S. H. (2001). Activities of the APN to enhance unpartnered elders self-efficacy after myocardial infarction. *Clinical Nurse Specialist, 15,* 60-66.

Castro, C. M., King, A. C., & Brassington, G. S. (2001). Telephone versus mail interventions for maintenance of physical activity in older adults. *Health Psychol., 20,* 438-444.

Celler, B. G., Earnshaw, W., Ilsar, E. D., Betbeder-Matibet, L., Harris, M. F., Clark, R. et al. (1995). Remote monitoring of health status of the elderly at home. A multidisciplinary project on aging at the University of New South Wales. *Int.J Biomed.Comput., 40,* 147-155.

Chan, F. Y., Soong, B., Watson, D., & Whitehall, J. (2001). Realtime fetal ultrasound by telemedicine in Queensland. A successful venture? *J Telemed.Telecare, 7 Suppl 2,* 7-11.

Chan, M., Bocquet, H., Campo, E., Val, T., Esteve, D., & Pous, J. (1998). Multisensor system and artificial intelligence in housing for the elderly. *Stud.Health Technol Inform., 48,* 145-149.

CHIPP Diabetic Retinopathy project. http://www.hc-sc.gc.ca/ohih-bsi/about_apropos/chipp-ppics/proj/westnet_e.html. Last viewed 13 January 2003.

Cochrane Collaboration Review Manager. http://www.cochrane-net.org/revman/

Coogle, C. L., Osgood, N. J., Parham, I. A., Wood, H. E., & et al. (1996). The effectiveness of videoconferencing in geriatric alcoholism education. *Gerontology & Geriatrics Education, 16,* 73-83.

Cooper, M. & Keating, D. (1996). Implications of the emerging home systems technologies for rehabilitation. *Med Eng Phys., 18,* 176-180.

Cresswell, S. & Hicks, K. (1996). A new modem-based communication link for paediatric home peritoneal dialysis patients. *Dialysis and Transplantation, 25(9),* 586-590.

Currell, R., Urquhart, C., Wainwright, P., & Lewis, R. (2001). Telemedicine versus face to face patient care: effects on professional practice and health care outcomes. The Cochrane Library [Issue 4]. Update Software.

Dansky, K. H., Bowles, K. H., & Palmer, L. (1999). How telehomecare affects patients. *Caring, 18,* 10-14.

Dansky, K. H., Palmer, L., Shea, D., & Bowles, K. H. (2001). Cost analysis of telehomecare. *Telemed.J E Health, 7,* 225-232.

Darkins, A., Dearden, C. H., Rocke, L. G., Martin, J. B., Sibson, L., Wootton, R. (1996). An evaluation of telemedical support for a minor treatment centre. *J Telemed.Telecare, 2,* 93-99.

Davis, M. C. (1997). Teleradiology in rural imaging centres. *J Telemed.Telecare, 3,*146-153.

Dawson, A., Cohen, D., Candelier, C., Jones, G., Sanders, J., Thompson, A. et al. (1999). Domiciliary midwifery support in high-risk pregnancy incorporating telephonic fetal heart rate monitoring: a health technology randomized assessment. *J Telemed Telecare, 5(4)*, 220-230.

De Leo, D., Carollo, G., & Dello, B. M. (1995). Lower suicide rates associated with a Tele-Help/Tele-Check service for the elderly at home. *American Journal of Psychiatry, 152,* 632-634.

Della Mea, V., Cortolezzis, D., Beltrami, C.A. (2000). The economics of telepathology--a case study. *J Telemed Telecare, 6 Suppl 1*, S168-S169.

de Lusignan, S., Wells, S., Johnson, P., Meredith, K., & Leatham, E. (2001). Compliance and effectiveness of 1 year's home telemonitoring. The report of a pilot study of patients with chronic heart failure. *Eur.J Heart Fail., 3,* 723-730.

Demiris, G., Speedie, S. M., & Finkelstein, S. (2001). Change of patients' perceptions of TeleHomeCare. *Telemed.J E Health, 7,* 241-248.

Dick, P. T., Filler, R., & Pavan, A. (1999). Participant satisfaction and comfort with multidisciplinary pediatric telemedicine consultations. *J Pediatr Surg, 34,* 137-141.

Dini, E. F., Linkins, R. W., & Chaney, M. (1995). Effectiveness of computer-generated telephone messages in increasing clinic visits. *Archives of Pediatrics & Adolescent Medicine, 149,* 902-905.

Doolittle, G.C., Harmon, A., Williams, A., Allen, A., Boysen, C.D., Wittman, C. et al. (1997). A cost analysis of a tele-oncology practice. *J Telemed Telecare, 3 Suppl 1*, 20-22.

Doolittle, G. C., Yaezel, A., Otto, F., & Clemens, C. (1998). Hospice care using home-based telemedicine systems. *J Telemed.Telecare, 4 Suppl 1,* 58-59.

Doolittle, G. C. (2000). A cost measurement study for a home-based telehospice service. *J Telemed.Telecare, 6 Suppl 1,* S193-S195.

Doze, S. and Simpson, J. (1997). *Evaluation of a telepsychiatry pilot project*. Alberta Heritage Foundation for Medical Research.

Doze, S., Simpson, J., Hailey, D., Jacobs, P. (1999). Evaluation of a telepsychiatry pilot project. *J Telemed Telecare, 5(1)*, 38-46.

Drummond, M., O'Brien, B., Stoddard, G., & Torrence, G. (1997). *Methods for the economic evaluation of health care programmes. Second Ed.* Oxford, New York: Oxford University Press.

Eedy, D. J. & Wootton, R. (2001). Teledermatology: a review. *Br.J Dermatol., 144,* 696-707.

Elford, D. R., White, H., St John, K., Maddigan, B., Ghandi, M., & Bowering, R. (2001). A prospective satisfaction study and cost analysis of a pilot child telepsychiatry service in Newfoundland. *J Telemed.Telecare, 7,* 73-81.

Ferris, D. G., Macfee, M. S., Miller, J. A., Litaker, M. S., Crawley, D., & Watson, D. (2002). The efficacy of telecolposcopy compared with traditional colposcopy. *Obstet.Gynecol., 99,* 248-254.

Finley, J. P., Sharratt, G. P., Nanton, M. A., Chen, R. P., Ryan, P., Wolstenholme, J. et al. (1997). pediatric echocardiography by telemedicine: Nine years experience. Journal of Telemedicine and Telecare 3[4], 200-204.

Franken, E. A., Jr., Whitten, P., & Smith, W. L. (1996). Teleradiology services for a rural hospital: a case study. *J Telemed.Telecare, 2,* 155-160.

Friedman, R. H., Kazis, L. E., Jette, A., Smith, M. B., Stollerman, J., Torgerson, J. et al. (1996). A telecommunications system for monitoring and counseling patients with hypertension. Impact on medication adherence and blood pressure control. *Am J Hypertens., 9,* 285-292.

Fulmer, T. T., Feldman, P. H., Kim, T. S., Carty, B., Beers, M., Molina, M. et al. (1999). Intervention study to enhance medication compliance in community-dwelling elderly individuals. *Journal of Gerontological Nursing, 25,* 6-14.

Gallienne, R. L., Moore, S. M., & Brennan, P. F. (1993). Alzheimer's caregivers: psychosocial support via computer networks. *Journal of Gerontological Nursing, 19,* 15-22.

Garshnek, V. & Burkle, F. M., Jr. (1999). Applications of telemedicine and telecommunications to disaster medicine: historical and future perspectives. *J Am Med Inform.Assoc, 6,* 26-37.

Go, R. C., Duke, L. W., Harrell, L. E., Cody, H., Bassett, S. S., Folstein, M. F. et al. (1997). Development and validation of a Structured Telephone Interview for Dementia Assessment (STIDA): the NIMH Genetics Initiative. *J Geriatr.Psychiatry Neurol., 10,* 161-167.

Going E. (1998). Telehealth in dialysis: the Simcoe County experience. *Journal of the Canadian Association of Nephrology Nurses and Technicians, 8(3)*, 36-38.

Gray, J., Pompilio-Weitzner, G., Jones, P. C., Wang, Q., Coriat, M., & Safran, C. (1998). Baby CareLink: development and implementation of a WWW-based system for neonatal home telemedicine. *Proc AMIA.Symp.,* 351-355.

Gray, J. E., Safran, C., Davis, R. B., Pompilio-Weitzner, G., Stewart, J. E., Zaccagnini, L. et al. (2000). Baby CareLink: using the internet and telemedicine to improve care for high-risk infants. *Pediatrics, 106,* 1318-1324.

Grigsby, J., Kaehny, M. M., Sandberg, E. J., Schlenker, R. E., & Shaughnessy, P. W. (1995). Effects and effectiveness of telemedicine. *Health Care Financ.Rev., 17,* 115-131.

Hailey, D. & Crowe, B. L. (2000). Assessing the economic impact of telemedicine. *Disease Management & Health Outcomes, 7,* 187-192.

Hailey, D., Roine, R., & Ohinmaa, A. (2002). Systematic review of evidence for the benefits of telemedicine. *Journal of Telemedicine and Telecare, 8(Suppl. 1)*: S1:1-7.

Hakansson, S. & Gavelin, C. (2000). What do we really know about the cost-effectiveness of telemedicine? *J Telemed.Telecare, 6 Suppl 1,* S133-S136.

Halvorsen, P. A. & Kristiansen, I. S. (1996). Radiology services for remote communities: cost minimisation study of telemedicine. *BMJ, 312,* 1333-1336.

Halvorsen, P.A., Kristiansen, I.S. (1997). Does teleradiography in primary health care reduce costs? An analysis based on utilization of radiographic examination in the municipality of Alta. *Tidsskr Nor Laegeforen, 117(11),* 1611-1615.

Hanson, E. J. & Clarke, A. (2000). Role of telematics in assisting family carers and frail older people at home. *Health and Social Care in the Community, 8,* 129-137.

Hauber, R. P., Jones, M. L., Temkin, A. J., & Vesmarovich, S. (1999). Extending the continuum of care after spinal cord injury through telerehabilitation. *Topics in Spinal Cord Injury Rehabilitation* 5[3], 11-20.

Health Canada, First Nations and Inuit Health Branch (2001). *Community services in the 21st century: First nations and Inuit telehealth services*. National First Nations Telehealth Research Project HTF-NA402. Publications Health Canada, Ottawa, Canada.

Hegarty, K., Byrne, G., & Del Mar, C. (1996). A pilot study of computer-assisted screening for depression in the elderly in general practice. *Informatics in Healthcare Australia, 5,* 166-168.

Heidenreich, P. A., Ruggerio, C. M., & Massie, B. M. (1999). Effect of a home monitoring system on hospitalization and resource use for patients with heart failure. *American Heart Journal, 138(4 pt 1)*, 633-640.

Hersh, W. R., Wallace, J., Patterson, P. K., & et al (2001). Telemedicine for the Medicare Population: Pediatric, obstetric and clinician-indirect home interventions. *Evid.Rep.Technol.Assess.(Suppl.), 24*.

Hersh, W. R., Helfand, M., Wallace, J., Kraemer, D., Patterson, P., Shapiro, S. et al. (2001). Clinical outcomes resulting from telemedicine interventions: a systematic review. *BMC Medical Informatics and Decision Making, 1,* 1-9.

Horio, H., Murakami, M., Chiba, Y., & Inada, H. (1998). Fetal monitor for non-stress-test screening at home. *Biomedical Instrumentation & Technology, 32,* 39-47.

Hui, E., Woo, J., Hjelm, M., Zhang, Y. T., & Tsui, H. T. (2001). Telemedicine: a pilot study in nursing home residents. *Gerontology, 47,* 82-87.

Hunkeler, E. M., Meresman, J. F., Hargreaves, W. A., Fireman, B., Berman, W. H., Kirsch, A. J. et al. (2000). Efficacy of nurse telehealth care and peer support in augmenting treatment of depression in primary care. *Arch.Fam.Med, 9,* 700-708.

Infante-Rivard, C., Krieger, M., Petitclerc, M., & Baumgarten, M. (1988). A telephone support service to reduce medical care use among the elderly. *Journal of the American Geriatrics Society, 36,* 306-311.

James, L. C., Folen, R. A., & Earles, J. (2001). Behavioral telehealth applications in the treatment of obese soldiers: A feasibility project and a report on preliminary findings. *Military Psychology, 13,* 177-186.

Jennett, P. A., Hall, W. G., Morin, J. E., & Watanabe, M. (1995). Evaluation of a distance consulting service based on interactive video and integrated computerized technology. *J Telemed.Telecare, 1,* 69-78.

Jerant, A. F., Azari, R., & Nesbitt, T. S. (2001). Reducing the cost of frequent hospital admissions for congestive heart failure: a randomized trial of a home telecare intervention. *Med Care, 39,* 1234-1245.

Jin, C., Ishikawa, A., Sengoku, Y., & Ohyanagi, T. (2000). A telehealth project for supporting an isolated physiotherapist in a rural community of Hokkaido. *J Telemed.Telecare, 6 Suppl 2,* S35-S37.

Johnson, A., Gorman, M., Lewis, C., Baker, F., Coulehan, N., & Rader, J. (2001). Interactive videoconferencing improves nutrition intervention in a rural population. Journal of the American Dietetic Association 101[2], 173-174.

Johnson, M. A., Davis, P., McEwan, A. J., Jhangri, G. S., Warshawski, R., Gargum, A. et al. (1998). Preliminary findings from a teleultrasound study in Alberta. *Telemed.J, 4,* 267-276.

Johnson, P. & Andrews, D. C. (1996). Remote continuous physiological monitoring in the home. *J Telemed.Telecare, 2,* 107-113.

Johnson, R. J. (1998). The potential for Ontario region's health information system to facilitate case management, program planning, and evaluation and to promote enhanced First Nations' control of health services. *Int.J.Circumpolar.Health, 57 Suppl 1,* 671-674.

Johnston, B., Wheeler, L., Deuser, J., & Sousa, K. H. (2000). Outcomes of the Kaiser Permanente Tele-Home Health Research Project. *Arch.Fam.Med, 9,* 40-45.

Johnston, D. & Jones, B. N., III (2001). Telepsychiatry consultations to a rural nursing facility: a 2-year experience. *J Geriatr Psychiatry Neurol, 14,* 72-75.

Jones III, B. N., Johnston, D., Reboussin, B., & McCall, W. V. (2001). Reliability of telepsychiatry assessments: Subjective versus observational ratings. *Journal of Geriatric Psychiatry & Neurology, 14,* 66-71.

Jovell, A.J. and Navarro-Rubio, M.D. (1995). Evaluation of Scientific Evidence. *Medicina clinica (Barc), 105*(19), 740-743.

Kallis, J. M., Gonzalez Del Rey, J. A., Ruddy, R. M., & Schubert, C. J. (1999). Linking emergency department patients to primary care: Phone vs face-to- face interaction. *Academic Emergency Medicine, 6,* 817-822.

Kates, N., Crustolo, A. M., Nikolaou, L., Craven, M. A., & Farrar, S. (1997). Providing psychiatric backup to family physicians by telephone. *Can.J Psychiatry, 42,* 955-959.

Kinsella, A. (1998). Home telecare in the United States. *J Telemed.Telecare, 4,* 195-200.

Kirby, M. (2002). *The Health of Canadians – The Federal Role*, Volumes 1-6. Ottawa, Standing Senate Committee on Social Affairs, Science and Technology.

Kobza, L. & Scheurich, A. (2000). The impact of telemedicine on outcomes of chronic wounds in the home care setting. *Ostomy.Wound.Manage, 46,* 48-53.

Kummervold, P. (2001). Social support in a wired world - Use of online mental health forums in Norway. *Technology and Health Care, 9,* 329.

Lamb, A., Eydmann, M., & Boddy, K. (1997). Remote maternity clinics. *British Journal of Healthcare Computing & Information Management, 14,* 22-24.

Lapham, S. C., Henley, E., & Kleyboecker, K. (1993). Prenatal behavioral risk screening by computer among Native Americans. *Fam.Med., 25,* 197-202.

Larsson, A., Nystrom, C., Vikstrom, S., Walfridsson, T., & Soderback, I. (1995). Computer-assistive cognitive rehabilitation for adults with traumatic brain damage: four case studies. *Occupational Therapy International, 2,* 166-189.

Lessing, K. & Blignault, I. (2001). Mental health telemedicine programmes in Australia. *J Telemed.Telecare, 7,* 317-323.

Liesenfeld, B., Renner, R., Neese, M., & Hepp, K. D. (2000). Telemedical care reduces hypoglycemias and improves glycemic control in children and adolescents with type 1 diabetes. *Diabetes Technol.Ther., 2,* 561-567.

Lieu, T. A., Capra, A. M., Makol, J., Black, S. B., & Shinefield, H. R. (1998). Effectiveness and cost-effectiveness of letters, automated telephone messages, or both for underimmunized children in a health maintenance organization. *Pediatrics, 101,* E3.

LifeMasters (2001). Solid outcomes show e-health and chronically ill senior populations are compatible. *Dis Manag Advis, 7,* 103-6, 97.

Loane, M. W. R. (2001). A review of telehealth. Medical Principals and Practice 10[4], 163-170.

Lobley, D. (1997). The economics of telemedicine. *J Telemed.Telecare, 3,* 117-125.

Lyketsos, C. G., Roques, C., Hovanec, L., & Jones, B. N., III (2001). Telemedicine use and the reduction of psychiatric admissions from a long-term care facility. *J Geriatr Psychiatry Neurol, 14,* 76-79.

Lynch, D. J., Tamburrino, M. B., & Nagel, R. (1997). Telephone counseling for patients with minor depression: preliminary findings in a family practice setting. *J Fam.Pract.,*
44, 293-298.

Maass, M., Kosonen, M., & Kormano, M. (2000). Transportation savings and medical benefits of a teleneuroradiological network. *J Telemed.Telecare, 6,* 142-146.

Macduff, C., West, B., & Harvey, S. (2001). Telemedicine in rural care. Part 2: assessing the wider issues. *Nursing Standard, 15,* 33-37.

Magnusson, L., Berthold, H., Chambers, M., Brito, L., Emery, D., & Daly, T. (1998). Using telematics with older people: the ACTION project. Assisting Carers using Telematics Interventions to meet Older persons' Needs. *Nurs.Stand., 13,* 36-40.

Mahoney, D., Tennstedt, S., Friedman, R., & Heeren, T. (1999). An automated telephone system for monitoring the functional status of community-residing elders. *Gerontologist,*
39, 229-234.

Mahoney, D. M., Tarlow, B., Jones, R. N., Tennstedt, S., & Kasten, L. (2001). Factors affecting the use of a telephone-based intervention for caregivers of people with Alzheimer's disease. *J Telemed.Telecare, 7,* 139-148.

Mair, F., Wilkinson, M., Bonnar, S. A., Wootton, R., & Angus, R. M. (1999). The role telecare in the managament of exacerbations of chronic obstructive pulmonary disease in the home. *Journal of Telemedicine & Telecare, 5,* 66-67.

Mair, F. & Whitten, P. (2000). Systematic review of studies of patient satisfaction with telemedicine. *BMJ, 320,* 1517-1520.

Mair, F. S., Haycox, A., May, C., & Williams, T. (2000). A review of telemedicine cost-effectiveness studies. *J Telemed.Telecare, 6 Suppl 1,* S38-S40.

Malagodi, M. & Smith, S. (1999). Prospective role for telemedicine as a communication tool for rural rehabilitation practice. *Work, 12,* 245-259.

Malone, F. D., Athanassiou, A., Craigo, S. D., Simpson, L. L., & D'Alton, M. E. (1998). Cost issues surrounding the use of computerized telemedicine for obstetric ultrasonography. *Ultrasound Obstet.Gynecol., 12,* 120-124.

Markson, L. J., Friedman, R. H., Jette, A. M., & Kazis, L. (1992). Computers as clinician extenders: monitoring chronic illness in elderly patients. *International Journal of Technology and Aging, 5,* 153-165.

Massman, N.J., Dodge, J.D., Fortman, K.K., Schwartz, K.J., Solem, L.D. (1999). Burns follow-up: an innovative application of telemedicine. *Journal of Telemedicine & Telecare, 5 Suppl 1,* S52-4.

McCullough, A. (2001). Viability and effectiveness of teletherapy for pre-school children with special needs. *Int J Lang Commun Disord, 36 suppl,* 321-326.

McGrew, K. B. & Quinn, C. A. (1997). Examining the effectiveness of telephone assessment and care planning for homecare services. *Generations, 21,* 66-67.

Mease, A., Whitlock, W.L., Brown, A., Moore, K., Pavliscsak, H., Dingbaum, A., Lacefield, D., Buker, K., Xenakis, S. (2000). Telemedicine improved diabetic management. *Military Medicine*, *165*(8):579-584.

Mehta, A. R., Wakefield, D. S., Kienzle, M. G., & Scholz, T. D. (2001). Pediatric tele-echocardiography: evaluation of transmission modalities. *Telemed.J E Health, 7,* 17-25.

Mielonen, M. L., Ohinmaa, A., Moring, J., & Isohanni, M. (2000). Psychiatric inpatient care planning via telemedicine. *J Telemed.Telecare, 6,* 152-157.

Miller, E. A. (2001). Telemedicine and doctor-patient communication: an analytical survey of the literature. *Journal of Telemedicine and Telecare, 7,* 1-17.

Minister of Research, Science and Technology of Quebec, & Minister of Health and Social Services of Quebec (1999). *Telehealth and telemedicine in Quebec: current issues.* (Rep. No. I-81). Canada.

Monrad Aas, I. H. (2002). Changes in the job situation due to telemedicine. *J Telemed.Telecare, 8,* 41-47.

Montani, C., Billaud, N., Tyrrell, J., Fluchaire, I., Malterre, C., Lauvernay, N. et al. (1997). Psychological impact of a remote psychometric consultation with hospitalized elderly people. *J Telemed.Telecare, 3,* 140-145.

Montgomery, A. A., Fahey, T., Peters, T. J., MacIntosh, C., & Sharp, D. J. (2000). Evaluation of computer based clinical decision support system and risk chart for management of hypertension in primary care: randomized controlled trial. BMJ 320[7236], 686-690.

Mulholland, H. C., Casey, F., Brown, D., Corrigan, N., Quinn, M., McCord, B. et al. (1999). Application of a low cost telemedicine link to the diagnosis of neonatal congenital heart defects by remote consultation. *Heart, 82,* 217-221.

Naef, R. W., Perry, K. G., Jr., Magann, E. F., McLaughlin, B. N., Chauhan, S. P., & Morrison, J. C. (1998). Home blood pressure monitoring for pregnant patients with hypertension. *J Perinatol., 18,* 226-229.

Neafsey, P. J., Strickler, Z., Shellman, J., & Padula, A. T. (2001). Delivering health information about self-medication to older adults: use of touchscreen-equipped notebook computers. *J Gerontol.Nurs., 27,* 19-27.

Nesbitt, T. S., Hilty, D. M., Kuenneth, C. A., & Siefkin, A. (2000). Development of a telemedicine program. *Western Journal of Medicine, 173,* 169-174.

Noel, H. C. & Vogel, D. C. (2000). Resource costs and quality of life outcomes for homebound elderly using telemedicine integrated with nurse case management. *CareManagement, 6,* 22-31.

O'Neill, S. K., Denton, G. L., Brockway, P. D., Davidson, M., & Wallsten, D. (2000). *Demonstration of the usefulness of telehealth in providing enhanced primary health services to the northern, geographically remote communities of Trout Lake, Peerless Lake, and Red Earth Creek, Alberta.* Slave Lake, Alta.: Keeweetinok Lakes Regional Health Authority No. 15.

Oakley, A. M., Kerr, P., Duffill, M., Rademaker, M., Fleischl, P., Bradford, N. et al. (2000). Patient cost-benefits of realtime teledermatology--a comparison of data from Northern Ireland and New Zealand. *J Telemed.Telecare, 6,* 97-101.

Ohinmaa, A., Hailey, D., and Roine, R. (1999). *The assessment of telemedicine: general principles and a systematic review*. Edmonton, AB, Alberta Heritage Foundation for Medical Research.

Otto, C. A. (1999). Telemedicine in the Canadian High Arctic and Other Remote Environments. *Proceedings of the 21st IEEE Engineering in Medicine and Biology Society Conference, 2,* 709.

Phillips, V. L., Temkin, A. J., Vesmarovich, S. H., & Burns, R. (1998). A feasibility study of video-based home telecare for clients with spinal cord injuries. *J Telemed.Telecare, 4,* 219-223.

Phillips, V. L., Temkin, A., Vesmarovich, S., Burns, R., & Idleman, L. (1999). Using telehealth interventions to prevent pressure ulcers in newly injured spinal cord injury patients post-discharge. Results from a pilot study. *Int.J Technol.Assess.Health Care, 15,* 749-755.

Phillips, V. L., Vesmarovich, S., Hauber, R., Wiggers, E., & Egner, A. (2001). Telehealth: reaching out to newly injured spinal cord patients. *Public Health Rep., 116 Suppl 1,* 94-102.

Picot J, Heaton L, Robichaud S, et al. (June, 2001). *Qualitative Evaluation of a Tele-dialysis Pilot Project*. Presentation.

Piette, J. D., Weinberger, M., & McPhee, S. J. (2000). The effect of automated calls with telephone nurse follow-up on patient-centered outcomes of diabetes care: a randomized, controlled trial. *Med Care, 38,* 218-230.

Piette, J. D., Weinberger, M., Kraemer, F. B., & McPhee, S. J. (2001). Impact of automated calls with nurse follow-up on diabetes treatment outcomes in a Department of Veterans Affairs Health Care System: a randomized controlled trial. *Diabetes Care, 24,* 202-208.

Popescu, V., Burdea, G., Bouzit, M., Girone, M., & Hentz, V. (1999). PC-based telerehabilitation system with force feedback. *Stud.Health Technol Inform., 62,* 261-267.

Premier's Advisory Council on Health for Alberta (2002). *A framework for reform* (Mazankowski Report). Edmonton, Premier's Advisory Council.

Pringle Specht, J.K., Wakefield, B., Flanagan, J. (2001). Evaluating the cost of one telehealth application connecting an acute and long-term care setting. *J Gerontol Nurs, 27(1),* 34-39.

Pullum, J. D., Sanddal, N. D., & Obbink, K. (1999). Training for rural prehospital providers: a retrospective analysis from Montana. *Prehosp.Emerg Care, 3,* 231-238.

Reid, J. (1996). *A telemedicine primer: understanding the issues.* Billings, MT.: Innovative Medical Communications.

Rendina, M. C., Long, W. A., & deBliek, R. (1997). Effect size and experimental power analysis in a paediatric cardiology telemedicine system. *J Telemed.Telecare, 3 Suppl 1,* 56-57.

Rendina, M. C. (1998). The effect of telemedicine on neonatal intensive care unit length of stay in very low birthweight infants. *Proc.AMIA.Symp.,* 111-115.

Rendina, M. C., Bose, C. L., Gallaher, K. J., Long, W. A., Ciszek, T. A., Baush, C. M. et al. (1998). The effect of a neonatal telecardiology system on respiratory therapy in very low birthweight infants. *Medinfo., 9 Pt 1,* 298-301.

Rendina, M. C., Downs, S. M., Carasco, N., Loonsk, J., & Bose, C. L. (1998). Effect of telemedicine on health outcomes in 87 infants requiring neonatal intensive care. *Telemed.J, 4,* 345-351.

Rendina, M. C., Carrasco, N., Wood, B., Cameron, A., & Bose, C. (2001). A logic model for the effect of telecardiology on acute newborn transfers. *Int J Technol Assess.Health Care, 17,* 244-249.

Riegel, B., Carlson, B., Kopp, Z., LePetri, B., Glaser, D., & Unger, A. (2002). Effect of a standardized nurse case-management telephone intervention on resource use in patients with chronic heart failure. Arch Intern Med 162[6], 705-712.

Rogers, M. A., Small, D., Buchan, D. A., Butch, C. A., Stewart, C. M., Krenzer, B. E. et al. (2001). Home monitoring service improves mean arterial pressure in patients with essential hypertension. A randomized, controlled trial. *Ann.Intern.Med, 134,* 1024-1032.

Rohland, B. M. (2001). Telepsychiatry in the heartland: if we build it, will they come? *Community Ment.Health J, 37,* 449-459.

Roine, R., Ohinmaa, A., & Hailey, D. (2001). Assessing telemedicine: a systematic review of the literature. *CMAJ, 165,* 765-771.

Romanow, R.J., Commission on the Future of Health Care in Canada (2002). *Building on Value: The Future of Health Care in Canada – Final Report.* Ottawa, Canadian Government Publishing, Communication Canada.

Rooney, E. M., Studenski, S. A., Roman, L. L., & Tangalos, E. G. (1997). A model for nurse case-managed home care using televideo. *Journal of the American Geriatrics Society, 45,* 1523-1528+1533.

Roush, R. E. & Teasdale, T. A. (1997). Reduced hospitalization rates of two sets of community-residing older adults after use of a personal response system. *Journal of Applied Gerontology, 16,* 355-366.

Sable, C., Roca, T., Gold, J., Gutierrez, A., Gulotta, E., & Culpepper, W. (1999). Live transmission of neonatal echocardiograms from underserved areas: accuracy, patient care, and cost. *Telemed.J, 5,* 339-347.

Sable, C., Cummings, S., Pearson, G., Schratz, L., Cross, R., Quivers, E. et al. (2002). Impact of telemedicine on the practice of pediatric cardiology in community hospitals. *Pediatrics, 109*(1), e3.

Scalvini, S., Zanelli, E., Domenighini, D., Massarelli, G., Zampini, P., Giordano, A. et al. (1999). Telecardiology community: a new approach to take care of cardiac patients. "Boario Home-Care" Investigators. *Cardiologia, 44,* 921-924.

Schinke, S. P., Moncher, M. S., & Singer, B. R. (1994). Native American youths and cancer risk reduction. Effects of software intervention. *J.Adolesc.Health, 15,* 105-110.

Scholz, T. D. & Kienzle, M. G. (1999). Optimizing utilization of pediatric echocardiography and implications for telemedicine. *Am J Cardiol., 83,* 1645-1648.

Schopp, L., Johnstone, B., & Merrell, D. (2000). Telehealth and neuropsychological assessment: New opportunities for psychologists. *Professional Psychology - Research & Practice, 31,* 179-183.

Schopp, L. H., Johnstone, B. R., & Merveille, O. C. (2000). Multidimensional telecare strategies for rural residents with brain injury. *Journal of Telemedicine and Telecare,*
6, 146-149.

Shah, N. B., Der, E., Ruggerio, C., Heidenreich, P. A., & Massie, B. M. (1998). Prevention of hospitalizations for heart failure with an interactive home monitoring program. *American Heart Journal, 135,* 373-378.

Simon, G. E., VonKorff, M., Rutter, C., & Wagner, E. (2000). Randomised trial of monitoring, feedback, and management of care by telephone to improve treatment of depression in primary care. *BMJ, 320,* 550-554.

Simpson, J., Doze, S., Urness, D., Hailey, D., & Jacobs, P. (2001). Telepsychiatry as a routine service--the perspective of the patient. *J Telemed.Telecare, 7,* 155-160.

Smith, A. C., Isles, A., McCrossin, R., Van der, W. J., Williams, M., Woollett, H. et al. (2001). The point-of-referral barrier--a factor in the success of telehealth. *J Telemed.Telecare, 7 Suppl 2,* 75-78.

Sparks, K. E., Shaw, D. K., Eddy, D., Hanigosky, P., & Vantrese, J. (1993). Alternatives for cardiac rehabilitation patients unable to return to a hospital-based program. *Heart & Lung: Journal of Critical Care, 22,* 298-303.

Squires, R. W., Miller, T. D., Harn, T., Micheels, T. A., & Palma, T. A. (1991). Transtelephonic electrocardiographic monitoring of cardiac rehabilitation exercise sessions in coronary artery disease. *American Journal of Cardiology, 67,* 962-964.

Srikanthan, V. S., Pell, A. C. H., Prasad, N., Tait, G. W., Rae, A. P., Hogg, K. J. et al. (1997). Use of fax facility improves decision making regarding thrombolysis in acute myocardial infraction. *Heart, 78,* 198-200.

Stebbins, R.A. (2001). *Exploratory Research in the Social Sciences*. Thousand Oaks: Sage Publications.

Stern, H., Jeaco, S., & Millar, T. (1999). Computers in neurorehabilitation: what role do they play? Part 1. *British Journal of Occupational Therapy, 62,* 549-553.

Stewart, S., Vandenbroek, A.J., Pearson, S., Horowitz, J.D. (1999). Prolonged beneficial effects of a home-based intervention on unplanned readmissions and mortality

among patients with congestive heart failure. Archives of Internal Medicine 159[3], 257-261.

Stiles, N., Boosalis, M., Thompson, K., Stinnett, D., & Rayens, M. K. (1998). Nutrition telemedicine consultation for rural elders. *Journal of Nutrition for the Elderly, 18,* 47-55.

Stoeger, A., Strohmayr, W., Giacomuzzi, S. M., Dessl, A., Buchberger, W., & Jaschke, W. (1997). A cost analysis of an emergency computerized tomography teleradiology system. *J Telemed.Telecare, 3,* 35-39.

Strawn, B. D., Hester, S., & Brown, W. S. (1998). Telecare: a social support intervention for family caregivers of dementia victims. *Clinical Gerontologist, 18,* 66-69.

Subirana Serrate, R., Ferrer-Roca, O., & Gonzalez-Davila, E. (2001). A cost-minimization analysis of oncology home care versus hospital care. *Journal of Telemedicine and Telecare*, 7[4], 226-232.

Swanson, B. (1999). Information technology and under-served communities. *J Telemed.Telecare, 5 Suppl 2,* S3-10.

Swinson, R. P., Fergus, K. D., Cox, B. J., & Wickwire, K. (1995). Efficacy of telephone-administered behavioral therapy for panic disorder with agoraphobia. *Behaviour Research & Therapy, 33,* 465-469.

Tang, P. (2000). *Telecare: new ideas for care and support @ home* (Rep. No. Policy Paper). University of Bristol: Policy Press.

Tang, P. & Venables, T. (2000). 'Smart' homes and telecare for independent living. *J Telemed.Telecare, 6,* 8-14.

Tang, W. K., Chiu, H., Woo, J., Hjelm, M., & Hui, E. (2001). Telepsychiatry in psychogeriatric service: a pilot study. *Int J Geriatr Psychiatry, 16,* 88-93.

Taylor, P. (1998). A survey of research in telemedicine. 1: Telemedicine systems. *J Telemed.Telecare, 4,* 1-17.

Taylor, P. (1998). A survey of research in telemedicine. 2: Telemedicine services. *J Telemed.Telecare, 4,* 63-71.

Thome, M. & Alder, B. (1999). A telephone intervention to reduce fatigue and symptom distress in mothers with difficult infants in the community. *Journal of Advanced Nursing,*
29, 128-137.

Trauth, E. (2001). *Qualitative Research in IS: Issues and Trends*. Hershey: Idea Group Publishing.

Trott, P. & Blignault, I. (1998). Cost evaluation of a telepsychiatry service in northern Queensland. *J Telemed.Telecare, 4 Suppl 1,* 66-68.

Tsang, M. W., Mok, M., Kam, G., Jung, M., Tang, A., Chan, U. et al. (2001). Improvement in diabetes control with a monitoring system based on a hand-held, touch-screen electronic diary. *J Telemed.Telecare, 7,* 47-50.

Tsilimigaki, A., Maraka, S., Tsekoura, T., Agelakou, V., Vekiou, A., Paphitis, C. et al. (2001). Eighteen months' experience with remote diagnosis, management and education in congenital heart disease. *J Telemed.Telecare, 7,* 239-243.

Tually, P., Parrish, F., Walker, J. (1999). Nuclear medicine teleradiology in regional and rural centres of Western Australia. *J Telemed Telecare, 5 Suppl 1,* S47-S50.

Tually, P., Walker, J., & Cowell, S. (2001). The effect of nuclear medicine telediagnosis on diagnostic pathways and management in rural and remote regions of Western Australia. *J Telemed.Telecare, 7 Suppl 2,* 50-53.

Vassallo, D. J., Hoque, F., Roberts, M. F., Patterson, V., Swinfen, P., & Swinfen, R. (2001). An evaluation of the first year's experience with a low-cost telemedicine link in Bangladesh. *J Telemed.Telecare, 7,* 125-138.

Vesmarovich, S., Walker, T., Hauber, R. P., Temkin, A., & Burns, R. (1999). Use of telerehabilitation to manage pressure ulcers in persons with spinal cord injuries. *Adv Wound.Care, 12,* 264-269.

Wagner, M. M. & Hogan, W. R. (1996). The accuracy of medication data in an outpatient electronic medical record. *J Am Med Inform.Assoc., 3,* 234-244.

Walz, M., Bolte, R., Lehmann, K.J., Lutgemeier, J., Georgi, M. (1999). Economic analysis of teleradiology applications with KAMEDIN. *Stud Health Technol Inform, 64*, 208-216.

Wasson, J., Gaudette, C., Whaley, F., Sauvigne, A., Baribeau, P., & Welch, H. G. (1992). Telephone care as a substitute for routine clinic follow-up. *JAMA, 267,* 1788-1793.

Watanabe, M., Jennett, P., Watson, M. (1999). The effect of information technology on the physician workforce and health care in isolated communities: the Canadian picture. *J Telemed Telecare, 5 Suppl 2*, S11-S19.

Weinberger, M., Nagle, B., Hanlon, J. T., Samsa, G. P., Schmader, K., Landsman, P. B. et al. (1994). Assessing health-related quality of life in elderly outpatients: Telephone versus face-to-face administration. *Journal of the American Geriatrics Society, 42,* 1295-1299.

Welch, H. G., Johnson, D. J., & Edson, R. (2000). Telephone care as an adjunct to routine medical follow-up. A negative randomized trial. *Eff.Clin.Pract., 3,* 123-130.

Whitten, P., Mair, F., & Collins, B. (1997). Home telenursing in Kansas: patients' perceptions of uses and benefits. *J Telemed.Telecare, 3 Suppl 1,* 67-69.

Whitten, P., Kingsley, C., Cook, D., Swirczynski, D., & Doolittle, G. (2001). School-based telehealth: an empirical analysis of teacher, nurse, and administrator perceptions. *J Sch Health, 71,* 173-179.

Whitten, P. (2002). Systematic review of cost effectiveness studies of telemedicine interventions. BMJ 324, 1434-1437.

Williams, T. L., May, C. R., & Esmail, A. (2001). Limitations of patient satisfaction studies in telehealthcare: a systematic review of the literature. *Telemed.J E Health, 7,* 293-316.

Woods, K. F., Johnson, J. A., Kutlar, A., Daitch, L., & Stachura, M. E. (2000). Sickle cell disease telemedicine network for rural outreach. *J Telemed.Telecare, 6,* 285-290.

Wootton, R. (2001). Telemedicine and developing countries--successful implementation will require a shared approach. *J Telemed.Telecare, 7 Suppl 1,* 1-6.

Zelickson, B. D. & Homan, L. (1997). Teledermatology in the nursing home. *Arch.Dermatol., 133,* 171-174.

Zhang, Y., Bai, J., Zhou, X., Dai, B., Cui, Z., Lin, J. et al. (1997). First trial of home ECG and blood pressure telemonitoring system in Macau. *Telemed.J, 3,* 67-72.

Zwolan, T. A., Connor, C. M., & Kileny, P. R. (2000). Evaluation of the Foundations in Speech Perception software as a hearing rehabilitation tool for use at home. *Journal of the Academy of Rehabilitative Audiology, 33,* 39-51.

APPENDIX A

Team Members

Dr. Penny Jennett – Principal Investigator

Head, Health Telematics Unit; Professor Faculty of Medicine, University of Calgary

Expertise contributed: Extensive experience as a telehealth and health researcher, including leadership positions in data and literature synthesis in telehealth, telelearning and medical/health education.

Role: Direct the project, coordinate the efforts of the investigators and provide independent verification of article selection.

Dr. Richard Scott – Co-Investigator

Associate Professor, Health Telematics Unit, University of Calgary; Fullbright New Century Scholar

Expertise contributed: Diverse experience in review and synthesis of literature; telehealth researcher.

Dr. David Hailey – Co-Investigator

Director, David Hailey and Associates, Canberra, Australia; Professor, Department of Public Health Sciences, University of Alberta, Senior Advisor, Health Technology Assessment, Alberta Heritage Foundation for Medical Research

Expertise contributed: Data synthesis and analysis gained over numerous projects, including three previous non-quantitative reviews in telehealth; specific cost-benefit experience.

Dr. Arto Ohinmaa – Co-Investigator

Associate Professor (Health Economics), Department of Public Health Sciences, University of Alberta

Expertise contributed: Expertise in the area of health economics; significant experience in performing systematic reviews in telehealth as well as years of front-line experience in telehealth research projects.

Dr. Roger Thomas – Co-Investigator

Family Physician; Professor, Faculty of Medicine, University of Calgary; Cochrane Collaboration Coordinator for the University of Calgary

Expertise contributed: Clinical experience; expertise in sociology, evidence based medicine and systematic reviews; particular expertise in the Cochrane review process.

Carol Anderson – Co-Investigator

Telehealth Consultant, CA Consulting

Expertise contributed: clinical experience; telehealth consultant

Dr. Barbara Young – Co-Investigator

Clinical Fellow in Internal Medicine; Chief Resident General Internal Medicine, McGill University

Expertise contributed: experience in clinical medicine and medical education; interest in rural clinical medicine.

Diane Lorenzetti

Research Librarian, Institute of Health Economics/Centre for Health and Policy Studies, University of Calgary

Expertise contributed: advisor on search strategy and Reference Manager software

Louise Affleck Hall

Project Manager, Health Telematics Unit (HTU), University of Calgary

Lorna Milkovich

Project Coordinator, HTU

Caroline Claussen

Research Assistant, HTU

Tara Perverseff

Research Assistant, HTU

Susan Brownell

Project Assistant, HTU

Ali Jadavji

Summer Student, HTU

Julianne Sanguins

Summer Student, HTU

Stephanie Yeo

Summer Student, HTU

Local Policy Team Advisors

Advisors will contribute specific areas of expertise towards implementing a rational review design and drawing relevant conclusions from the results. All advisors will contribute up to five hours per month, with the exception of Ms. Lorenzetti, who will contribute approximately 100 hours over the course of the review process.

Dr. Tom Noseworthy

Intensive Care Physician; Information Communications Technology (ICT) and Policy Researcher, Department of Community Health Sciences, University of Calgary

Expertise contributed: expertise in health care policy and management based on practical and academic experience on multiple administrative levels; special expertise in telehealth

Dr. Steve Edworthy

Rheumatologist; Telehealth Researcher, Health Telematics Unit, University of Calgary

Expertise contributed: clinical experience; special expertise in ICT solutions as applied to the management of chronic diseases and physician offices.

Dr. David Topps

Family Physician; Chair, WONCA Rural Information Technology Exchange; Chair, Rural Practice Committee, College of Family Physicians

Expertise contributed: clinical experience; expertise in systematic reviews and the challenges of rural medicine, specifically as these relate to ICT use in practice.

Janice Hopkins

Director, Knowledge and Policy Development Office, Office of Health and the Information Highway, Health Canada

Expertise contributed: expertise in national policy as it applies to ICT implementation in the public sector

Dr. Penny Hawe

Professor, Markin Chair in Health, Wellness and Society, University of Calgary

Expertise contributed: expertise in policy, public health, epidemiology, psychology and evaluation of health promotion programs

Steven Lewis

Adjunct Professor of Health Policy, University of Calgary; Health Policy Consultant, University of Saskatoon.

Expertise contributed: many years experience in national and provincial health policy research and research synthesis

Dr. Robert Hayward

Physician (Internist); ICT Researcher, Department of Public Health Sciences, University of Alberta

Expertise contributed: clinical and ICT researcher within the health sector