

Evidence *in* Context

Issue: The Potential for Telehealth
Consultations in Cardiology and Dermatology
Released: April 2013

Health research — synthesized and contextualized for use in Newfoundland & Labrador

The Potential for Telehealth Consultations in Cardiology and Dermatology in Newfoundland and Labrador:

A Synthesis of Research Evidence

Pablo Navarro, Boyd Rowe, Stephen Bornstein

Newfoundland & Labrador Centre for

**APPLIED
HEALTH
RESEARCH**

www.nlcahr.mun.ca

CHRSP Reports are available online:
[www.nlcahr.mun.ca/research/ CHRSP](http://www.nlcahr.mun.ca/research/CHRSP)

This contextualized health research synthesis report was prepared by the Newfoundland & Labrador Centre for Applied Health Research (NLCAHR), Memorial University. It was developed through the analysis, interpretation and synthesis of scientific research and/or health technology assessments conducted by other parties. It also incorporates selected information provided by experts in the subject areas and synthesis methodologies. This document may not fully reflect all the scientific evidence available at the time this report was prepared. Other relevant scientific findings may have been reported since completion of this synthesis report.

Memorial University, NLCAHR, and the CHRSP project team make no warranty, express or implied, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, data, product, or process disclosed in this report. Conclusions drawn from, or actions undertaken on the basis of, information included in this report are the sole responsibility of the user.

This report is the property of the Newfoundland & Labrador Centre for Applied Health Research (NLCAHR). Reproduction of this document for non-commercial purposes is permitted provided proper credit is given to NLCAHR.

For further information please contact: nlcahr@mun.ca

Cite as: Navarro, P., Rowe, B., Bornstein, S. (2013). The Potential for Telehealth Consultations in Cardiology and Dermatology in Newfoundland & Labrador: A Synthesis of Research Evidence. St. John's, NL: Newfoundland & Labrador Centre for Applied Health Research, Memorial University

ISBN: 978-0-88901-441-1

Contents

About This Report	iv
About NLCAHR.....	iv
About the Contextualized Health Research Synthesis Program	iv
About Our Partners	v
Who Should Read This Report?.....	v
Researchers and Consultants.....	vi
Acronyms	vii
Glossary.....	viii
The Research Question	11
Key Messages from this Report	11
Background	12
What is a telehealth specialist-patient consultation?	13
Telehealth in Newfoundland and Labrador.....	14
What did we look for?	18
What is the evidence?	21
Cardiology	22
Summary of the evidence	22
Effectiveness	22
Unintended effects.....	23
Equity.....	23
Health economics.....	23
Feasibility.....	24
Acceptability.....	24
Dermatology	25
Summary of the evidence	25
Effectiveness	25
Unintended Effects.....	27
Equity.....	27
Cost effectiveness	27
Feasibility.....	28
Acceptability.....	28
The Newfoundland and Labrador Context	29
References	32

About This Report

About NLCAHR

The Newfoundland and Labrador Centre for Applied Health Research, established in 1999, contributes to the effectiveness of health and community services in Newfoundland and Labrador and to the physical, social, and psychological wellbeing of its population. NLCAHR accomplishes this mandate by building capacity in applied health research, supporting high-quality research, and fostering the effective use of research evidence by decision makers and policy makers in the provincial healthcare system.

About the Contextualized Health Research Synthesis Program

In 2007, NLCAHR launched the Contextualized Health Research Synthesis Program (CHRSP) to provide research evidence that would guide decision makers in the provincial health system on issues of pressing interest to Newfoundland and Labrador. Rather than conducting original research, CHRSP analyzes findings from high-level research already conducted in the subject area, such as systematic reviews, meta-analyses and health technology assessments. Findings are then synthesized and subjected to a systematic process of contextualization: they are analyzed in terms of their applicability to the conditions and capacities of the unique context of Newfoundland and Labrador. Our contextual analysis includes assessing the specific forms an issue may take in this province as well as the applicability of any proposed solutions and methods to locally available resources, infrastructure, human resources, cultural conditions and financial capacities.

CHRSP uses a combination of external experts and local networks to carry out and contextualize the research synthesis and to facilitate the uptake of the results by research users. CHRSP focuses on three types of projects: health services/ health policy projects, health technology assessment (HTA) projects, and projects that combine the two to examine processes for the organization or delivery of care involving a health technology.

About Our Partners

For this project, NLCAHR partnered with Labrador-Grenfell Health and the Canadian Agency for Drugs and Technologies in Health (CADTH). Senior administrators from Labrador-Grenfell Health proposed the research topic while CADTH helped the research team refine the research question. CADTH also identified relevant research literature, appraising and synthesizing the evidence in a peer-reviewed report. The work by CADTH has been published independently and is available for viewing on the NLCAHR website: www.nlcahr.mun.ca/chrsp. The CHRSP Project Team, with input from key stakeholders throughout the province, provided additional analysis and contextualization of the CADTH results for Newfoundland and Labrador.

Who Should Read This Report?

This report provides a synthesis of relevant research evidence on the clinical and cost effectiveness of telehealth technologies for specialist-patient consultations in the fields of cardiology and dermatology. The report is intended to inform and assist decision makers in the Labrador-Grenfell Regional Health Authority, the Newfoundland and Labrador Department of Health and Community Services and the province's other Regional Health Authorities by providing research evidence surrounding the effectiveness of telehealth consultation as an intervention for cardiology or dermatology patients. The findings of our synthesis are specifically interpreted for the context of Newfoundland and Labrador. Decision makers from other jurisdictions, particularly those with similar features in terms of potential clients, geography and resources, may also find the content helpful. The report includes explanations of research terms and technical language; as such, there is no need to have a specialized medical or health background to understand its content.

Researchers and Consultants

Project Team

Pablo Navarro

Research Officer
NLCAHR
(CHRSP Project Coordinator)

Boyd Rowe

Chief Executive Officer (now retired)
Labrador-Grenfell Health
(Health System Partner)

Stephen Bornstein, PhD

Director, NLCAHR
(CHRSP Program Director)

Wayne Gulliver, MD

Chair of Dermatology
Professor of Medicine
Faculty of Medicine
Memorial University

Bruce Sussex, MD

Professor of Medicine (Cardiology)
Faculty of Medicine
Memorial University

Consultants from the Newfoundland and Labrador Centre for Health Information (NLCHI)

Joanne Reid

Provincial Telehealth Coordinator
NLCHI

Mary Slade

Manager, Clinical Information Programs
(Telehealth and PACS)
NLCHI

Canadian Agency for Drugs and Technologies in Health (CADTH) Team

Cardiology:

Gaetanne Murphy

Research Officer
CADTH

Melissa Severn

Information Specialist
CADTH

Dermatology:

Sarah Ndegwa

Research Officer
CADTH

Sarah McGill

Information Specialist
CADTH

Cardiology and Dermatology:

Wendy Prichett-Pejic

Research Assistant
CADTH

External Reviewers

Jafna L. Cox, BA, MD, FRCPC, FACC

Director of Research, Division of Cardiology
Professor of Medicine and of
Community Health and Epidemiology
Dalhousie University

Stuart Peacock, BA, MSc, DPhil (Economics)

Associate Professor, University of British Columbia
Co-Director, Canadian Centre for Applied Research in
Cancer Control (ARCC)

Acronyms

AMSTAR	Assessment of Multiple Systematic Reviews
CADTH	Canadian Agency for Drugs and Technologies in Health
CI	Confidence Interval
CIHR-ISPR	Canadian Institutes of Health Research – Institute of Health Services and Policy Research
DHCS	Department of Health and Community Services (Government of Newfoundland and Labrador)
ECG	Echocardiogram
FTF	Face-to-face
HTA	Health Technology Assessment
HTIS	Health Technology Information Systems (CADTH)
ICER	Incremental Cost-Effectiveness Ratio
ICU	Intensive Care Unit
KTE	Knowledge Transfer and Exchange
LI	Live Interactive
MeSH	Medical Subject Headings
MUN	Memorial University
NICU	Neonatal Intensive Care Unit
NLCAHR	Newfoundland and Labrador Centre for Applied Health Research
NLCHI	Newfoundland and Labrador Centre for Health Information
NNT	Number Needed to Treat
QALY	Quality-Adjusted Life Years
RCT	Randomized Controlled Trials
RHA	Regional Health Authority
RR	Relative Risk
SF	Store and Forward

Glossary

AMSTAR	An 11-item instrument used to assess the methodological rigor of systematic reviews.
Auscultation	The act of listening to internal organs in order to diagnose possible disease.
Blinding	An experimental design feature where participants in a study, (i.e. researchers and/or research subjects) are not aware of the research subject's membership in the treatment or control group in order to minimize potential sources of bias. In a single-blind trial, research subjects do not know if they are in the intervention or control group. In a double-blind trial, neither the research subjects nor the researchers responsible for measuring the outcomes of interest know if the subject is in the intervention group or in the control group.
Confidence interval (CI)	A measure of the reliability of an estimate. CI specifies a range within which the true value of the estimated parameter is expected to lie. For ratios, if the CI spans 1, e.g., a relative risk CI of 0.8 to 1.3, the comparison in question is not statistically significant. Likewise, for comparisons of test score differences, if the CI spans 0, e.g., a difference in mean values CI of -2.4 to 3.2, then the comparison in question is also not statistically significant. When the CI spans those critical values, the treatment group and the control group cannot be considered different from one another on the measure in question.
Cohort	A group of people who share a common characteristic or experience within a defined period (e.g., are born, are exposed to a drug or vaccine or pollutant, or undergo a certain medical procedure).
Cost-effectiveness analysis	An economic analysis that compares interventions in terms of monetary cost and a common, desired outcome (i.e., an effect). The results of such an analysis are expressed in terms of cost per unit of effect, e.g., number of dollars spent for every additional year of life, or in terms of unit of effect per cost, e.g., number of additional days of life for every dollar spent. (1)
Cost-minimization analysis	A study comparing the monetary costs of two or more programs that are equivalent in terms of health outcomes. (1)
Cost-utility analysis	An economic analysis that compares interventions in terms of a single outcome or multiple outcomes that are combined. The single or combined outcome is measured in units that capture both the <i>quantity</i> and <i>quality</i> of the effects of the intervention. The most common measure is the quality-adjusted life-year or QALY. (See below.) (1)
Diagnostic accuracy	The probability that a test will correctly predict the presence or absence of disease when compared against the most reliable and accepted method of diagnosis.
Diagnostic reliability (Agreement)	The repeatability or reproducibility of an examination finding or other diagnostic assessment using the same or different (but not gold standard) diagnostic method. The kappa statistic is often used in diagnostic reliability assessments. A kappa value of 0.6 or higher is considered a substantially higher level of agreement than would be expected by chance alone, and is accepted as a benchmark of high reliability. (2-4)
Echocardiography (Echocardiogram)	A technique for investigating heart function using ultrasound.

Effect size	A measure of the strength of the relationship between two variables (for example, between a treatment for a health condition and recovery from that health condition). Effect sizes may be quantified by a range of different measures, including correlations, differences in means, and relative risks.
Effectiveness	The ability of an intervention to produce the desired beneficial effect in actual usage.
Efficacy	The ability of an intervention to produce a desired beneficial effect when delivered in ideal circumstances by trained and experienced specialists.
Grey literature	Research that is published non-commercially: grey literature may include reports carried out by governments, health authorities and not-for-profit associations.
Health equity	The differential impact that an intervention or exposure may have on a sub-group in a population. Often, health equity research examines how vulnerable groups may have poorer health outcomes from a given treatment or health service. However, health equity research may also study how other sub-groups who are not vulnerable or how some sub-groups may have better than average health outcomes.
Incidence	A measure of the number of new cases of a disease in a population over a period of time.
Incremental cost-effectiveness ratio (ICER)	The ratio of the difference in costs over the difference in effectiveness outcomes for the interventions being compared. (2)
Live Interactive (LI)	A telehealth technique that uses real time video-conferencing technologies to enable participants to interact in real time.
Meta-analysis	A type of systematic review that uses statistical techniques to quantitatively combine the findings from previous primary research studies.
Murmur (heart murmur)	An auscultatory sound of short duration made by the turbulent flow of blood.
Negative likelihood ratio	Ratio of the proportion of patients with disease who have a negative test result (false-negative rate) to the proportion of people without disease who have a negative test result (true-negative rate or specificity). (2)
Number needed to treat	A measure of treatment effectiveness. NNT is the number of patients that would have to be treated in order to prevent one additional adverse outcome among those patients. An ideal treatment would have NNT equal to 1, meaning that each patient treated will not experience the adverse outcome in question. The greater the NNT, the less effective the treatment in question.
Phonocardiography (phonocardiogram)	A technique to record the sounds of the heart with very high fidelity and to produce a graphic record of those sounds.
Positive likelihood ratio	Ratio of the proportion of patients <i>with</i> a disease who have a positive test result (true-positive rate or sensitivity) to the proportion of people <i>without</i> the disease who have a positive test result (false-positive rate).
Prevalence	A measure of the number of existing cases of a disease in a population at a particular time.
Primary research	Research that involves the collection and analysis of data from actual participants, as opposed to the synthesis of the findings of such research or secondary analyses of previously collected data.

QALY	A measure that combines time and an assessment of quality of life. QALY stands for “quality adjusted life year.” A QALY unit is based on a scale that considers one year of life lived in perfect health as worth 1 QALY. A year of life that is lived in a state of less than perfect health is worth less than 1 QALY. The quality of life is quantified as “the utility value,” a measure of the state of health of the person in question. To get a QALY value, the utility value is multiplied by the years lived in that state: UTILITY x TIME = QALY. QALYs are expressed in terms of “years lived in perfect health.” For example, half a year lived in perfect health is equivalent to 0.5 QALYs, the same as 1 year of life lived in a compromised state of health with a utility of 0.5. (1)
Randomized controlled trial (RCT)	An experimental design for testing the effectiveness of an intervention. RCTs randomly allocate research participants to a treatment and a comparison group, e.g., a placebo or usual care group, in order to minimize potential sources of bias.
Relative risk (RR)	A measure of the likelihood that an exposure will have a particular outcome. In the case of health treatments, RR is the ratio of the probability of an outcome occurring in a treated group compared to the probability of its occurring in an untreated group. <ul style="list-style-type: none"> • RR of 1 means that there is no difference between the treated and untreated groups; • RR of less than 1 means the patients who received the treatment are less likely to have a specific outcome ; • RR of greater than 1 means patients who received the treatment are more likely to have a specific outcome
Sensitivity	The proportion of patients with disease who have a positive test result (true-positive).
Specificity	The proportion of patients without disease who have a negative test result (true-negative).
Store-and-Forward	A telehealth technique that uses asynchronous still digital image technology for communication, analogous to an e-mail system. Participants are typically separated by both time and space. (2)
Systematic review	A literature review (focused on a specific and explicit research question) that tries to identify, select, appraise and synthesize published and unpublished research evidence relevant to that question.
Teledermoscopy	An application of teledermatology involving the use of an epiluminescence microscope to create digital dermoscopic images useful for the early detection of malignant skin lesions. (2)
Telehealth	The use of advanced telecommunication technologies to exchange health information and to provide healthcare services across geographic, time, social and cultural barriers. (5)

The Research Question

“What does the scientific literature tell us about the clinical and economic effectiveness of telehealth technologies for specialist-patient consultations in the fields of cardiology and dermatology, considering the expected patient populations and given the social, geographic, economic, health system, health technology, and political contexts of Newfoundland and Labrador?”

Key Messages from this Report

1. There is insufficient available evidence to **conclusively support** either telecardiology or teledermatology consultations as an effective alternative to face-to-face consultations with patient/clients who live in rural or remote parts of Newfoundland and Labrador. Therefore, this report is limited to asserting that the evidence **suggests** the potential effectiveness of the telehealth consultations described below.
2. When teledermatology consultations are compared with conventional face-to-face consultations, the available evidence **suggests** that teledermatology consultations result in reliable diagnoses and management plans for most dermatologic conditions.
3. It is important to note that the available evidence **strongly cautions against** the use of store-and-forward teledermatology consultations for **pigmented or atypical lesions** as some studies show a significantly higher rate of inappropriate and potentially life-threatening management plans derived from such teledermatology consultations when compared with management plans derived from face-to-face consultations.
4. The available evidence **suggests** that, in both telecardiology and teledermatology, specialist-patient consultations may increase the number of such telehealth consultations while reducing inappropriate in-person referrals.
5. The available evidence **suggests** that both telecardiology and teledermatology are cost-effective from a societal perspective, provided that a telehealth communications infrastructure is already in place and operational (as is the case in Newfoundland and Labrador). The available evidence also **suggests** that both telecardiology and teledermatology are cost-effective from a patient/client perspective.
6. No evidence was found in the research literature to support or contradict the possibility that telehealth services would increase physician specialist workloads or overall cost to the health service payer/health system.
7. The available evidence **suggests** that patient satisfaction with teledermatology consultations is equal to satisfaction levels with face-to-face consultations.

Background

In 2011, Labrador-Grenfell Health proposed a CHRSP topic to study the potential health and economic benefits of telehealth technologies, including improved access to specialists, decreased wait times, decreased out-of-pocket costs and work days lost to travel for health reasons. NLCAHR partnered with Labrador-Grenfell Health and with the Canadian Agency for Drugs and Technologies in Health (CADTH) to address this topic. The original CHRSP study proposed to address a broad range of specialties in a number of different service contexts, such as consultations, case management, and discharge planning. Through consultations with our partners, the scope of the project was refined to two specialties that do not yet have an in-province telehealth program: cardiology and dermatology.¹

The CHRSP Project Team included a senior administrator from Labrador-Grenfell Health, clinical specialists in cardiology and dermatology, local telehealth experts from NLCHI, and CHRSP staff at NLCAHR. This team, in conjunction with CADTH, refined the original research question for this project to the following:

“What does the scientific literature tell us about the clinical effectiveness and cost-effectiveness of telehealth technologies for specialist-patient consultations in the fields of cardiology and dermatology, considering the expected patient populations and given the social, geographic, economic, health system, health technology, and political contexts of Newfoundland and Labrador?”

CADTH was tasked with:

- searching for, and identifying, relevant research literature (see “What did we look for?” below);
- critically appraising the evidence;
- producing two separate reports synthesizing the evidence for telecardiology and for teledermatology; and
- having those results peer-reviewed.

¹ The decision to focus our research on these particular specialties arose from several factors. First, NLCHI had just concluded an evaluation of existing telehealth programs. (8) Previous consultations with our health system partners had also indicated that telecardiology and teledermatology were considered important additions to the provincial telehealth program. (8) Furthermore, our health system partners agreed that the number of referrals to cardiologists and dermatologists for adults from rural and remote regions of Newfoundland and Labrador was sufficiently high to warrant investigating potential telehealth options for these patients.

CADTH modified the research question in order to examine three distinct aspects of telehealth for specialist-patient consultation:

1. *What is the diagnostic accuracy and reliability of telecardiology/ teledermatology consultations compared with current practice in remote or rural areas?*
2. *What are the benefits of telecardiology/ teledermatology consultations with regard to patient outcomes, wait times, avoidance of unnecessary clinic visits², patient-incurred costs, and patient satisfaction?*
3. *What are the economic impacts of telecardiology/teledermatology consultations on the healthcare system?*

The results of CADTH's research were published in two independent reports (2,3) whose findings form the basis for this report. The CHRSP Project Team took the CADTH results and, with input from our consultants (see page vi.), provided additional analysis and contextualization for Newfoundland and Labrador.

What is a telehealth specialist-patient consultation?

For the purposes of this project, a telehealth specialist-patient consultation is defined as communication about health concerns or health conditions between a specialist physician and a patient who are geographically distant from each other. The specialist physician is located at the host site, while the patient is located at the remote site. The patient may be assisted by a technician and/or a health care provider (e.g., a nurse, a nurse practitioner or another physician).

A telehealth specialist-patient consultation may include a live, interactive discussion between a physician and a patient. It may also include non-interactive elements, such as having the physician review medical information collected at the patient's location or having the physician access laboratory results processed at that location. For the purposes of this project, a specialist-patient consultation does not involve remotely administered diagnostic testing, remotely administered medical intervention, remote monitoring activities³, or any kind of telehealth communications among health professionals that do not involve the patient being present.

² The term "unnecessary or avoidable referrals/clinic visits" describes referrals for in-person clinic appointments that are not required for diagnosis and/or treatment. CADTH reports that the primary research studies had similar, though not identical, criteria for determining if a referral was unnecessary. These included: if the presenting condition could be managed by the family physician and if the patient was deemed not to require treatment upon presenting for an in-person clinic appointment.

³ Several procedures are now possible to administer remotely through a combination of systems of communications, sensors and robotics. These remotely administered procedures include: remote diagnostic testing involving the collection of samples from a patient, e.g., taking a biopsy or photograph; remotely-administered medical interventions, e.g., surgical removal of a mole; and remote monitoring of a patient, e.g., monitoring heart rhythm and heart rate.

Several types of telehealth techniques exist for specialist-patient telehealth consultations. The main techniques relevant to this project are Live Interactive (LI), Store and Forward (SF) and Hybrid:

- **Live Interactive (LI)** consultation is synchronous, with the communication between patient and specialist taking place at the same time. LI relies on high-quality video conferencing. In an LI specialist-patient consultation, a patient will be present at a telehealth centre that is equipped with high-resolution video and audio equipment. The video conferencing equipment is connected to a secure, encrypted health information network that provides a high level of visual and auditory fidelity and protects confidentiality. The specialist communicates from a desktop video conferencing system on his/her computer work-station and may have access to additional medical information during the consultation.
- **Store and Forward (SF)** consultation is asynchronous; the communication between patient and specialist takes place in staggered stages. SF may involve high-quality images or other test media that are collected at the remote site (or at a third party site such as a local hospital) and stored securely for review and reporting by the specialist at a later time. The specialist will then consult with the patient using some form of audio or video conferencing.
- **Hybrid** consultations use both LI and SF.

During the LI telehealth specialist-patient consultation, the specialist and patient may discuss symptoms and treatment options or review test results. The specialist may also prescribe medications, tests or treatments for the patient.

Telehealth in Newfoundland and Labrador

The Telemedicine Centre at Memorial University was established in 1976 under the leadership of Dr. A. Maxwell House. Operations commenced the following year, making the Newfoundland and Labrador facility the first major telemedicine centre in Canada. (6)

The Centre was later renamed the Telehealth and Educational Technology Resource Agency (TETRA) and given an expanded mandate to provide continuing education for health service providers. TETRA originally utilized satellite technologies that connected a set of remote centres throughout Newfoundland and Labrador with a host site located at the General Hospital/ Health Sciences Centre in St. John's. (6)

By 2005, technologies to support communication in the province had evolved to high-speed, dedicated internet connections. That year, through provision of joint funding from Canada Health Infoway and the provincial Department of Health and Community Services, the

Newfoundland and Labrador Centre for Health Information (NLCHI) and four Regional Health Authorities (RHAs) initiated the Newfoundland and Labrador Telehealth Strategic Plan (the Strategic Plan). (7) Under the Strategic Plan, telehealth was transformed from a largely project-funded, university-administered set of initiatives into a sustained approach to the development of infrastructure and utilization of telehealth technology to provide patient care in Newfoundland and Labrador. The new telehealth program operated through the RHAs and was coordinated by NLCHI. The Strategic Plan identified five key service priorities for telehealth in Newfoundland and Labrador, including access to tertiary services and specialists.

A teleoncology program was developed in 2004 and implemented in cooperation with Memorial University, Eastern Health's Cancer Care Program, and the three other RHAs. Teleoncology was the first integrated program implemented within the new telehealth system. A telepsychiatry program was then established in 2007, followed by telenephrology in 2008.

The provincial telehealth program now provides other available specialist services, including: dietetics, genetics, neurology, occupational therapy, physiotherapy, social work, pre-surgery consultation and post-surgery follow-up, and wound care.

In most instances, the specialists involved in telehealth are located in St. John's. Labrador-Grenfell Health also supports an independent telehealth program to offer services by family physicians and a small number of specialists. In addition, the province provides for some telehealth services by specialists located outside of the province, including respirology (i.e., pulmonology), urology, and some cardiology.

...Newfoundland and Labrador has a fully developed telehealth infrastructure that is versatile enough to provide services to many disciplines.

As of 2013, Newfoundland and Labrador has a fully developed telehealth infrastructure that is versatile enough to provide services to many disciplines. There are sixty-two active remote telehealth centres in Newfoundland and Labrador (see Figure 1) plus the main central site in St. John's. Several host sites are clustered in the St. John's area, with additional sites in Corner Brook and Happy Valley-Goose Bay. The Newfoundland and Labrador Centre for Health Information provides central booking and coordination services for most telehealth activities in the province. (8) Labrador-Grenfell Health (LGH) also provides booking and coordination services for a small number of intra-RHA telehealth services.

Each Regional Health Authority operates at least six remote telehealth centres; Labrador-Grenfell Health, with nineteen, has the highest number of centres. Labrador-Grenfell Health is the smallest RHA in terms of population size and the largest RHA by area. People in the Labrador-Grenfell RHA live in the most rural and remote parts of the province, including six

coastal communities that are not accessible by road. (See Figure 2.) Access to specialists is, therefore, particularly challenging in Labrador, because of logistics and the costs of travel. Depending on where they live, some patients are eligible to have some or all of their travel costs covered by Labrador-Grenfell Health and/or the Nunatsiavut Government.⁴

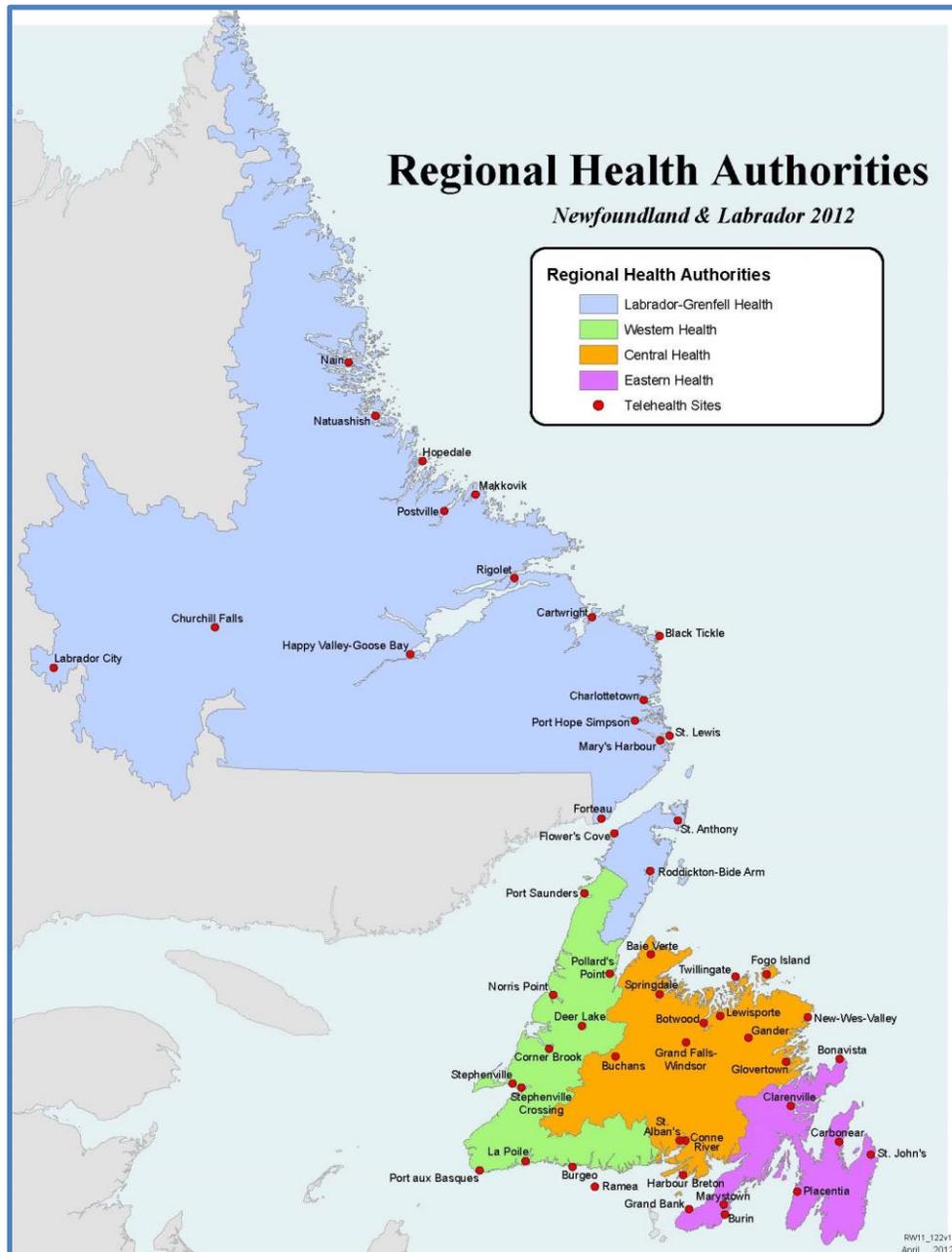


Figure 1: Telehealth Centres in Newfoundland and Labrador (<http://www.nlchi.nl.ca/index.php/telehealth>)

⁴ Labrador-Grenfell Health (LGH) provides a "medical flight authorization" voucher to residents from coastal communities in Northern Labrador (Rigolet to Nain) and Southern Labrador (Cartwright to Lodge Bay) for travel by LGH chartered aircraft to the nearest hospital (Happy Valley-Goose Bay for north coast, St. Anthony for south coast). All such passengers have to pay a nominal \$40 fee to travel. Beneficiaries of the Nunatsiavut Land Claims Agreement can claim a refund from the Nunatsiavut Government for travel and for non-insured benefits. The Nunatsiavut Government will also refund beneficiaries who require medical treatment from health facilities beyond Happy Valley-Goose Bay (e.g., flights and accommodations).

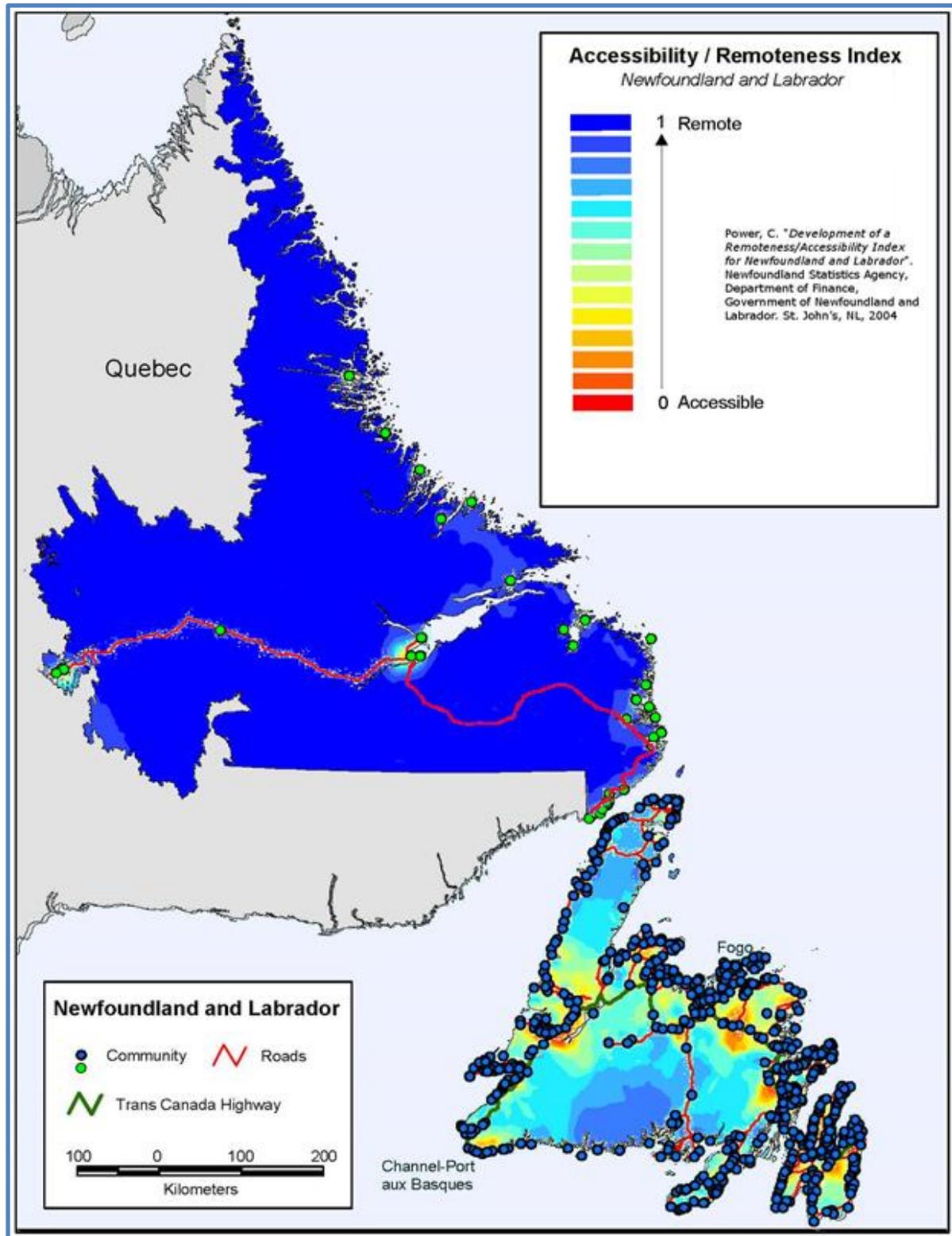


Figure 2: Accessibility/Remoteness Index for Newfoundland and Labrador

What did we look for?

CADTH's Health Technology Inquiry Service (HTIS) carried out the search for, and identification of, evidence for this project. The HTIS methodology for identifying evidence is very similar to CHRSP's in a number of ways:

1. The top-ranked evidence includes different kinds of systematic review literature, including systematic reviews, meta-analyses and health technology assessments (HTA).
2. Also included in the top-ranked evidence are high-quality primary research studies, e.g., large-scale randomized controlled trials that have been published too recently to be captured by the systematic review literature.
3. Both HTIS and CHRSP search periodical indexes for both published articles and grey (i.e., not commercially published) sources. A list of the health evidence databases used by HTIS in its literature searches is available on the CADTH website.⁴

The main difference between the CHRSP and HTIS methodologies is that HTIS will consider other types of evidence if systematic reviews and large-scale, recent RCTs are not available. HTIS will identify and attempt to synthesize research-based evidence from studies with less rigorous experimental designs, including cohort studies, case-control studies and observational studies. As mentioned above, CHRSP does not normally report primary research study results unless they are high-quality and recently published and, as a result, not captured by the review literature. In the case of this project, we report on CADTH's findings with the caution that the evidence they located is not sufficiently strong to unequivocally support any conclusions.

For this project, HTIS, on behalf of NLCAHR, sought research that studied, at least in part, patient-specialist consultations in telecardiology and teledermatology. HTIS carried out keyword and MeSH-term searches of several periodical indexes of peer-reviewed journals, as well as research databases and repositories of grey literature. HTIS also conducted open internet searches using Google and other search engines. (2,3) Article selection for both the telecardiology and teledermatology reports was based on the following inclusion criteria, organized using the PICOS classification (9):

- **Population:** patients living in remote or rural locations without access to specialists who require non-emergency consultation for medical diagnosis or treatment;
- **Intervention:** teledermatology or telecardiology technologies used for consultation with patients;
- **Comparator:** usual care, i.e., face-to-face consultations;

⁴ <http://www.cadth.ca/en/resources/grey-matters>

- **Outcomes:** patient clinical outcomes, health service utilization outcomes, quality of life and satisfaction outcomes, diagnostic accuracy and reliability, costs to the patient or healthcare payer, and cost effectiveness;
- **Study Design:** quantitative studies.

A full description of the search strategies can be found in Appendix 1 of the CADTH Teledermatology Report, (2, p32-34) and in Appendix 1 of the CADTH Telecardiology Report. (3, p20-29)

Search results are summarized in the figures on the following pages. For telecardiology, a total of 438 citations were identified in the initial search, of which 51 full text articles were retrieved for consideration. Nine of these were included in the final telecardiology analysis (see Figure 3.). (3) For teledermatology, 284 citations were identified in the initial search, of which 70 full text articles were retrieved for consideration. Sixteen studies were included in the final teledermatology analysis (see Figure 4.). (2)

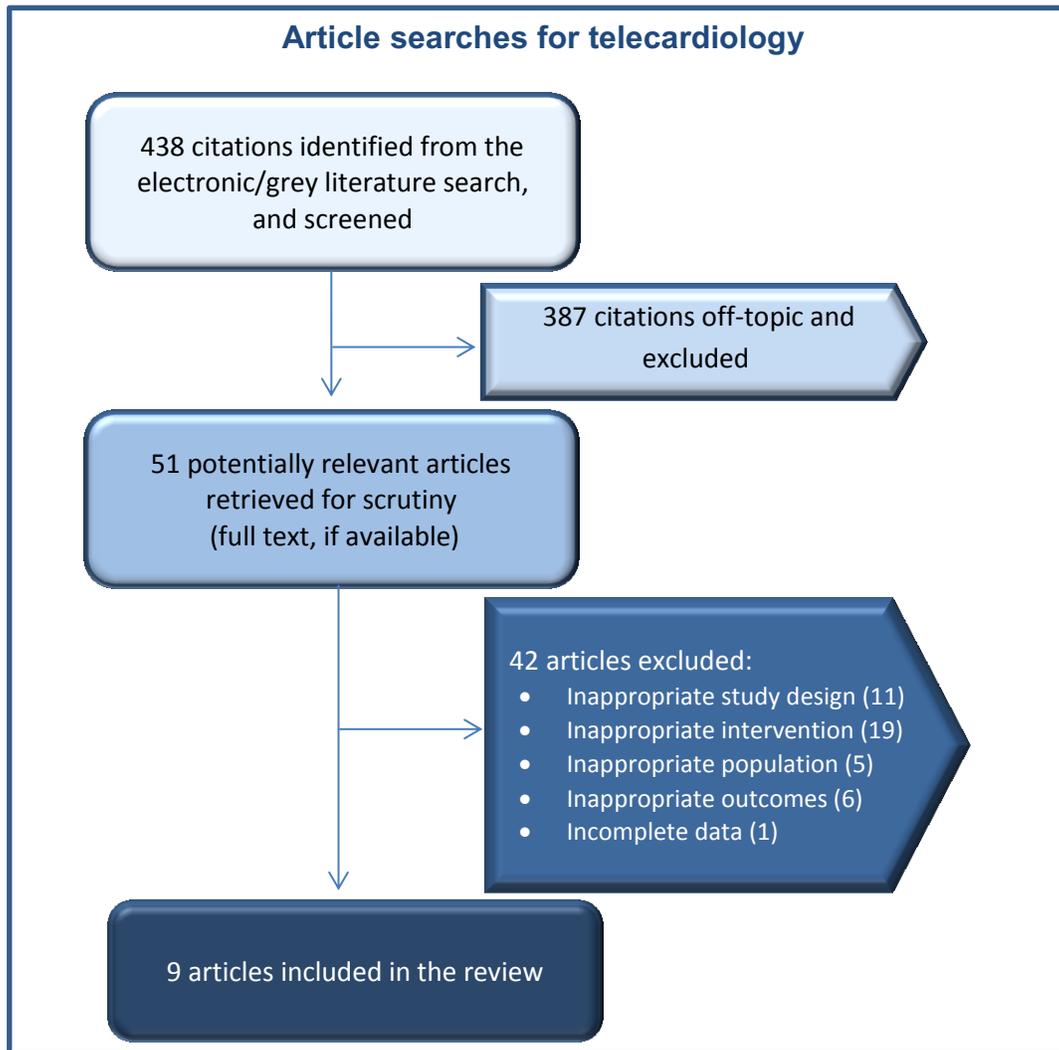


Figure 3: Article flow for telecardiology search (3)

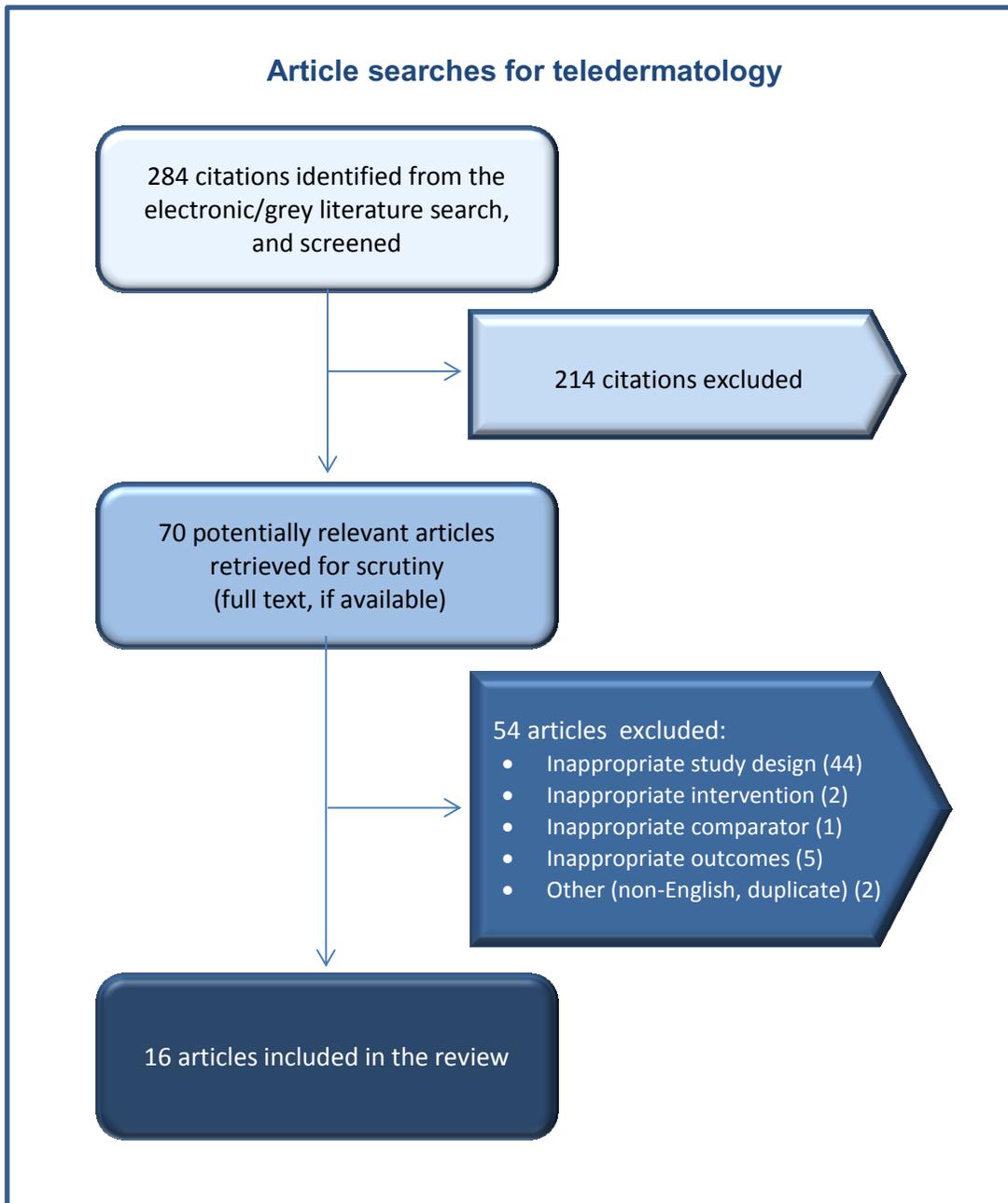


Figure 4: Article flow for teledermatology search (2)

What is the evidence?

General comments about the evidence

In the context of this report, an important feature of the syntheses for telecardiology and teledermatology is that neither subject generated any evidence at the level of a synthesis of primary research. There appear to be no systematic reviews, meta-analyses or health technology assessments published on either topic. Furthermore, there was relatively little evidence from high-quality primary research studies - namely, randomized controlled trials (RCTs). (2,3) The lack of systematic review studies in these fields results mainly from the small number of primary research studies.

In the CADTH Telecardiology Report, no RCTs were identified. The CADTH Teledermatology Report identified and included only four RCTs. The experimental designs of the remaining primary research studies were characterized by two significant limitations:

1. Potential risk of bias resulting from a lack of randomization and/or blinding;
2. Low statistical power resulting from patient samples that were small and/or not sufficiently diverse.

Both of these factors increase the likelihood of skewed or spurious findings. As a result, the reliability and the generalizability of the findings from these studies, while included in our synthesis, must be considered with caution and is not necessarily reproducible. (2,3)

The remainder of this section will summarize the findings from the CADTH reports and highlight those areas in which the evidence is convergent. However, it should be noted that since there is relatively little evidence, future research results could have a significant influence on the accepted benefits of telecardiology and teledermatology.

Cardiology

Summary of the evidence

Nine studies met the inclusion criteria (3):

- Three were diagnostic studies (10-12);
- One was an interrupted time-series study (13);
- Four reports were based on cohort studies, three from one cohort study and one from another separate cohort study (14-17);
- Five reports included cost analyses (12,15-18);
- Pediatric telecardiology programs were evaluated in two clinical studies (11,13) and four economic reports (12,15-17);
- Adult telecardiology programs were evaluated in two clinical studies (10,14) and one economic report. (18)

Overall, both the quantity and the quality of evidence from studies of telecardiology consultation programs were low.⁵ (3) Several studies lacked concurrent control groups or used control groups that were not sufficiently similar to the study group and, as a result, there are grounds for concern about the validity of comparisons between treatments. Other studies lacked randomization or included retrospective control groups, and this raises concerns about possible selection bias. Only one study was conducted inside Canada; this makes it difficult to apply the economic findings to Canada's or Newfoundland and Labrador's healthcare contexts. (3)

According to CADTH's review of the available literature, the evidence suggests that the implementation of clinic-based or hospital-based telecardiology programs is feasible for communities with limited access to cardiovascular specialists. (3) However, because of the limitations of the available evidence, firm conclusions regarding diagnostic accuracy or impact on patient outcomes cannot be made. None of the studies reported on wait times, and limited information was available on patient satisfaction with telecardiology programs. (3)

Overall, there is only limited evidence to guide decision makers who may be planning to implement telecardiology consultation services in their jurisdictions.

Effectiveness

Limited evidence is available for both pediatric and adult cardiology. The available evidence suggests that pediatric telecardiology has the potential to be accurate enough for remote diagnosis (11) but that additional research is required to solidify that finding. The evidence indicates that pediatric telecardiology can decrease transfer rates for patients by preventing

⁵ Please note that these findings relate only to telecardiology specialist-patient consultations. This synthesis of research-based evidence does not include remote cardiology monitoring or diagnostic testing.

unnecessary transfers, while increasing the percentage of real cardiac pathologies detected by making it possible to conduct a greater number of cardiology tests on pediatric patients. (13) Further evidence indicates that pediatric telecardiology can provide “timely specialist consultations” that may not have been otherwise available. (16) There is very little evidence related to the effectiveness of adult telecardiology. One study found that telecardiology may have the potential to deliver cardiovascular risk-reduction care for adults. (14) Another study suggested that telecardiology may be able to provide remote auscultation; however, that particular study had a very small sample size. (10)

Unintended effects

No unintended effects (positive or negative) were reported for either pediatric or adult telecardiology consultation programs. (3)

Equity

The main impact of telecardiology on health equity is to partially offset existing inequities in access to cardiologists between patient groups that live in proximity to centres with cardiology services and patient groups that live at a distance. The increase in identification of cardiac pathologies through testing under telehealth strongly suggests that remote and rural populations without the telehealth option may be under-served and may experience significant rates of undiagnosed cardiac disease. (13)

Health economics

The available evidence indicates that the most significant determinant of costs for telecardiology programs is the capital cost of the telehealth infrastructure. If the costs of designing and installing a telehealth infrastructure and support services are factored in, telecardiology programs are not cost-effective. However, if a telehealth infrastructure and supporting services are already in place, telecardiology programs have been shown to be cost-neutral or modestly cost-effective.

From a healthcare payer perspective, the identified health economic evidence indicates that telecardiology is cost-neutral or can provide modest cost savings after the required capital investments. This research was carried out in jurisdictions (the United Kingdom and Sweden) with public health insurance systems similar to Canada’s. Research by Grant et al. (12) indicated that pediatric telecardiology resulted in cost savings by reducing unnecessary referrals. Three studies by Dowie et al. (15-17) and one by Löfgren (18) indicate that the costs of telecardiology and face-to-face consultations are similar.

According to the CADTH report, a major determinant of cost in telecardiology programs is the volume of patients using the service: higher volumes reduce “the per-patient cost of acquiring and operating telemedicine equipment.” (3, p18)

Telecardiology programs have been consistently shown to reduce the number of patients required to travel for specialist care, and thus to reduce travel costs for patients and for healthcare payers where travel is subsidized. (3)

Feasibility

The feasibility of implementing a telecardiology program is addressed directly by PausJenssen and colleagues and Fragasso and colleagues. PausJenssen et al. assessed telecardiology for a cardiovascular risk-reduction program and found that existing staff required little additional training to deliver the telecardiology services. Fragasso et al. studied the accuracy of remote auscultation of heart and lung sounds, which, although outside the scope of this study, does nonetheless speak to the feasibility of implementing a telehealth program. They also found that delivering telehealth services required only a short period of training for existing staff and physicians. However, it must be noted that both the Fragasso et al. and PausJenssen et al. studies have small sample sizes and caution should be exercised in generalizing their findings. (10,14)

Despite the paucity of available evidence, the CADTH report does find that the "implementation of clinic or hospital-based telecardiology programs is feasible for communities with limited access to cardiovascular specialists." (3, p18) In this context, a key factor in determining the feasibility of a telecardiology program is whether or not a telehealth communications infrastructure is already in place (e.g., high-speed internet capacity, a coordination centre and services, and audio and video equipment at the remote and central locations). Where no communications infrastructure is available, the feasibility of a telecardiology program is severely limited.

The CADTH study does not report any evidence regarding how telecardiology programs may affect the workload of physicians, or any subsequent impacts on healthcare costs.

Acceptability

CADTH reports that there was little evidence on patient or physician satisfaction with telecardiology services. There was no evidence with regard to the integration of telecardiology programs with existing health services in any jurisdiction. Accordingly, the CADTH report was not able to draw any conclusions regarding the acceptability of telecardiology. (3)

Dermatology

Summary of the evidence

A total of sixteen studies met the inclusion criteria (2):

- Four were randomized controlled trials (19-22);
- Eight were non-randomized comparative studies (23-30);
- An additional four studies were economic evaluations (31-34);
- No systematic reviews, meta-analyses or health technology assessments were identified.

The quality of the primary research literature was varied. Three of the four RCTs had robust study designs and moderate samples sizes of approximately 450 to 700 patients. (19-21) The fourth RCT had a smaller sample size, difficulties with recruitment, and high attrition rates, all of which may compromise the validity of its findings. (22) The eight non-randomized comparative studies (23-30) were characterized by potential risks of bias, namely, non-representative sample populations and/or lack of blinding. The economic evaluations consisted of two cost-effectiveness studies and two cost-minimization studies with moderate to weak study designs. None of the studies were carried out in Canada and the results "may not be generalizable to the specific geographic requirements and public healthcare funding of a Canadian setting." (2)

According to CADTH, a synthesis of the available evidence indicates that teledermatology consultations "result in highly reliable diagnoses and management plans that compare favorably with conventional clinic-based care." (2, p3) However, CADTH also recommends caution with regard to the diagnostic accuracy of teledermatology, especially for pigmented or atypical lesions which can lead to skin cancer. Teledermatology was shown to consistently improve several process outcomes including wait time to be seen in a clinic, wait time to treatment, and the avoidance of unnecessary referrals, particularly by primary care physicians. (2)

While patient satisfaction did not differ between teledermatology and clinic-based care, primary care physicians expressed concern about increased workload and the potential complications involved in teledermatology, including using new computer equipment and software, as well as learning new scheduling systems. (2)

Effectiveness

Accuracy and Reliability

The main focus of the available evidence for the effectiveness of teledermatology was on the diagnostic reliability of consultations. The studies included in this report measure teledermatology accuracy against the accepted 'gold standard' of face-to-face (FTF) consultation. CADTH concluded that teledermatology, whether using store-and-forward (SF),

live interactive (LI) or hybrid techniques results in “highly reliable diagnoses and management plans that compare favorably with conventional clinic-based care.” (2, p. 3)

This finding applies to most dermatologic conditions, e.g., eczema, acne, psoriasis, and benign skin tumors. However, it is important to note that there is evidence that strongly cautions against the use of store-and-forward teledermatology instead of face-to-face consultations for: pigmented and atypical lesions that can develop into cancerous growths. The available evidence indicates that SF teledermatology consultation to diagnose and manage pigmented and atypical lesions lacks accuracy and reliability. (25, 28) CADTH notes: “this is particularly concerning in the field of skin cancer, where misdiagnosis could lead to significant morbidity and mortality.” (2, p. 3) CADTH did not identify any research or evidence studying LI or hybrid techniques for pigmented and atypical lesions.

Romero et al. (20) carried out an RCT comparing store-and-forward teledermatology with face-to-face consultations in various dermatologic conditions and reported high intra-observer diagnostic and treatment reliability. Interestingly, adding the LI component to a consultation did not increase the diagnostic or treatment reliability. However, the lack of information on blinding for the researchers (i.e., on whether or not the researchers were aware if a patient was in the study group or the control group) raises the potential for bias. (2)

Bowns et al. (22) also carried out an RCT studying the “clinical equivalence” of SF teledermatology and face-to-face consultations in cases of suspected malignant melanoma or squamous cell carcinoma. They found the level of agreement on management plans to be significantly low, while diagnostic agreement was only “modest” at 68%. CADTH concluded, however, that problems with the experimental design of this study introduced a significant risk of bias that precludes drawing any conclusions from the results.

Data from the non-randomized clinical trials consistently indicated that teledermatology consultations (SF or LI) for a range of dermatologic conditions, excluding pigmented and atypical lesions, resulted in highly reliable diagnoses. (26,29,30) Evidence from two of these studies also indicated that agreement on management plans for patients ranges from moderate to substantial. (26,29)

Clinical course

One RCT by Pak et al. (21) compared the clinical outcomes from store-and-forward teledermatology with those found in conventional clinic-based care. The results indicated no significant differences in the clinical course of a range of indications based on a three-point rating scale (improved, no change, worse). The RCT had a large sample size based in veterans’ hospitals and was well-powered (and thus able to determine intervention effects). However, the rating scale in question had limitations, including the unlikelihood that it would be “reliable across all dermatologic conditions” and “having only a fair inter-rater reliability score.” (2)

Other studies considered process outcomes, including time to clinic attendance, time to treatment, and avoidance of unnecessary referrals. (23,27,29) These studies all found that teledermatology improved process outcomes.

Referrals

From the evidence identified by CADTH, the most consistent findings are that teledermatology can improve wait times for patients and can decrease the number of unnecessary referrals. (2, p3) Eminovic et al. (19) carried out a large-scale cluster RCT and showed that SF teledermatology could reduce unnecessary referrals from primary care physicians by approximately 20%. A referral was considered unnecessary if “patients experienced full or partial recovery, the condition was considered treatable by a general practitioner, or the patient could not be treated.” (2)

Unintended Effects

As mentioned above, a very important finding is that there is evidence contradicting the use of SF teledermatology for pigmented and atypical lesions. Based on the research by Warshaw and colleagues (25), CADTH reports that an unintended effect of SF teledermatology is the potential to result in a “significantly higher rate of inappropriate management plans that were potentially life-threatening when compared with face-to-face consultations for pigmented or atypical lesions.” (2, p22)

Equity

The main impact of teledermatology on health equity is to help offset existing inequities between patient groups that live in or close to population centers with dermatologists and patient groups that live at a distance. (2)

Cost effectiveness

As with telecardiology, the main precondition for the cost-effectiveness of teledermatology is the availability of telehealth infrastructure and supporting services to facilitate the consultations. Where the costs of infrastructure and supporting services have to be factored in, there is no evidence that teledermatology is cost-effective. However, if both are in place as they are in Newfoundland and Labrador, SF teledermatology has been shown to be cost-effective from a societal perspective, largely through decreasing lost work-time that would otherwise result from travel to visit specialists:

Two cost-effectiveness studies found store-and-forward teledermatology to be the dominant intervention from a societal perspective when compared with conventional care for the management of patients with skin cancers. However, both of these studies assumed a public health setting with an established telecommunications infrastructure. A sensitivity analysis in one of these studies found that teledermatology was no longer dominant in the case where extra

costs were associated with the set-up and maintenance of a communication network exclusively used by teledermatology. (2, p. 23)

The economic evaluations included in the CADTH report did not find the same cost-effectiveness for LI teledermatology.

Feasibility

In contrast to the CADTH report on telecardiology, the CADTH report on dermatology explicitly excluded feasibility studies. The decision to do so was made by CADTH in consideration of its mandate, capacity, and other existing research. The CADTH report does not indicate any evidence regarding how teledermatology programs might affect the workload of physicians or any other impacts these programs might have on healthcare costs. There is some evidence citing concern among physicians about increased workloads (see below.).

Acceptability

Two RCT's indicated that patient satisfaction did not differ between teledermatology and face-to-face care. (19,22) A study carried out in Turkey reported that patient satisfaction improved when web cameras were added to SF teledermatology. (30) Conversely, one RCT found that only one in five primary care physicians was satisfied with teledermatology, with the others concerned over increased workload for a time-consuming and complex process. (22)

The Newfoundland and Labrador Context

Throughout the course of this project, the specific characteristics of Newfoundland and Labrador have been considered in relation to the research topic. We have identified contextual factors that may influence the relevance and applicability of the research-based evidence.

The following is a comprehensive table that lists relevant contextual factors.

Client-related factors	
Demographics	Patient-to-specialist ratios can be expected to support the implementation of a telecardiology or teledermatology program. Approximately 50% of the province's population lives two hours or more from St. John's, (35) where nearly all cardiologists and dermatologists practice and are likely to practice in the immediate future. (8) Furthermore, Newfoundland and Labrador is reported to have comparatively high rates of some dermatologic diseases, e.g., psoriasis (36) as well as a high proportion of older residents living in rural and remote areas. (35) This means that a substantial number of patients could be potential telehealth clients, which would increase the cost-effectiveness of the program from the societal perspective. The sustained use of a telehealth program for cardiology or dermatology is expected to improve the delivery of the service and clinical outcomes.
Acceptability	Patient acceptability can be expected to enhance the implementation of a telecardiology or teledermatology program. In the provincial telehealth program survey carried out by NLCHI, (8) patients had "a high level of satisfaction with most aspects of [existing] telehealth services." There appears to be openness in rural and remote areas of the province to adopting telehealth versions of specialist services, where possible.
Factors related to sites of service, the service design and service organization	
Infrastructure	A significant contextual factor influencing telecardiology and teledermatology is that a comprehensive and well-established telehealth infrastructure already exists in the province. This telehealth infrastructure includes communication channels and technologies, supporting organizational and technical services, and an established network of remote telehealth sites. In addition, the existing telehealth system includes trained, experienced and stable human resources. As a result, the existing telehealth infrastructure is expected to simplify the implementation of services and to reduce the costs.

Table 1: Factors of Relevance in Contextualization for Newfoundland and Labrador

Service Integration	Many of the telehealth services in NL are integrated into the existing patient appointment schedules of participating specialists. As a result, those telehealth patients are seen within the same scheduling context as in-person patients. This integration of services is intended to avoid an increase in the overall number of patients a specialist is expected to see in the course of a work week.
Site of service	From the specialist perspective, most of the telehealth services in NL are managed from office or clinic space that is already used for face-to-face consultations. As a result, the implementation of new telehealth programs in this manner is expected to contribute to their sustainability by reducing the number of potential challenges that specialists might experience under less integrated versions of telehealth, e.g., getting access to the site or working in a new environment.
Access to information	In NL, most telehealth physicians working from their offices or clinics have access to other forms of digital health record information, for example, laboratory test results or electronic hospital medical chart data. The information is presented on the same screens that are used to view and hear the patient. This access to additional information may contribute to increased clinical effectiveness compared to face-to-face consultation. It can also be expected to improve further as additional online health information becomes available in the future through the province's planned implementation of a province-wide interoperable electronic health record.
Wait times	Most cardiology and dermatology specialists have a tradition of spending parts of the year travelling to rural/remote areas. While they tend to see large numbers of patients during these visits, replacing travelling clinics with telehealth consultations could cut wait times for patients both in rural locations and in the St. John's area by reducing the time lost to travel and setup and reducing the specialists' absences from their regular practices.
Factors related to health human resources	
Training and experience	As mentioned above, the province has an established telehealth infrastructure that includes trained and experienced remote telehealth providers, organizational/administrative staff, and technical support staff. As a result, these human resources can be expected to contribute to the expected clinical and cost- effectiveness of a telecardiology or teledermatology program of services.
Existing ties with patients	As mentioned previously, cardiology and dermatology specialists currently working in NL commonly take time every year to travel to rural and/or remote parts of the province for a series of face-to-face clinics. As a result, these specialists have established ties with patients who would be candidates for telehealth consultations as well as with their family physicians. It is expected that these existing ties would enhance patient acceptance of telehealth services.

Table 1: (continued) Factors of Relevance in Contextualization for Newfoundland and Labrador

Acceptability	In the survey carried out by NLCHI, (8) health providers indicated that dermatology and internal medicine telehealth programs were considered priorities for the province. The acceptability of these telehealth programs among health providers may be a factor in easing the implementation of new programs in the province.
Economic Factors	
Travel subsidies	The province subsidizes some travel for patients requiring cardiology or dermatology consultations, and the cost of travel varies with the degree of remoteness of a patient's residence. A telehealth program would be expected to improve cost effectiveness from a health payer perspective for specialist consultations for any patients currently eligible for these subsidies.
Impact on referrals	A significant number of referrals for face-to-face consultations (presumed to be approximately 50% of referrals) are for patients who live in rural or remote areas of the province. The expected reduction in unnecessary referrals and a decrease in related travel are expected to improve the cost-effectiveness of telecardiology and teledermatology consultations from multiple perspectives: for the patient, out-of-pocket expenses and lost work time would be reduced; for the health payer, the number of referrals and the need for travel subsidies would decrease; from the societal perspective, lost work time is reduced.
Infrastructure costs	The province has developed an extensive telehealth infrastructure. As a result, the cost effectiveness of a telecardiology or teledermatology program is expected to significantly increase, according to research literature. Furthermore, not developing the full potential of the province's telehealth program may be considered an opportunity cost for the province, its healthcare system and NLCHI.
Political factors	
Public acceptability	The populations of Newfoundland and Labrador are increasingly utilizing telehealth programs in oncology, nephrology and mental health; there is expected uptake for other pilot projects as well, including a telehealth program on diabetes management. Evidence indicates that the population is responding favourably to telehealth programs and is open to having additional services provided in this manner. As a result, the implementation of telecardiology and teledermatology is expected to be supported by the public; conversely, a continued lack of access to these services may be expected to generate dissatisfaction.

Table 1: (continued) Factors of Relevance in Contextualization for Newfoundland and Labrador

References

- (1) Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. Basic types of economic evaluation. *Methods for the economic evaluation of health care programmes*. Third ed. New York: Oxford University Press; 2005. p. 6-28.
- (2) Ndegwa S, Prichett-Pejic W, McGill S. Teledermatology Services: A Rapid Review of the Diagnostic, Clinical Management, and Economic Outcomes. 2010;135. Available at: http://www.cadth.ca/media/pdf/H0502_Teledermatology_Report_e.pdf
- (3) Murphy G, Prichett-Pejic W, Severn M. Non-Emergency Telecardiology Services: A Rapid Review of Clinical and Cost Outcomes. 2010;134. Available at: http://www.cadth.ca/media/pdf/H0501_Telecardiology_Report_e.pdf
- (4) Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;159-174. DOI: 10.2307/2529310.
- (5) Reid J. *A Telemedicine Primer: Understanding the Issues*. West des Moines, Iowa: Innovative Medical Communications; 1996.
- (6) Elford ROD. Telemedicine activities at memorial University of Newfoundland: A historical review, 1975–1997. *Telemedicine Journal* 1998;4(3):207-224. DOI: 10.1089/tmj.1.1998.4.207.
- (7) Battcock A. *A Three-Year Provincial Telehealth Strategic Plan for Newfoundland and Labrador*. 2005. Available at: <http://www.eicp.ca/en/toolkit/information-technology/telehealth-strategic-plan-draft-v2.pdf>
- (8) *Evaluating the Benefits: Newfoundland and Labrador Provincial Telehealth Program, Chronic Disease Management*. 2010. Available at: <http://www.nlchi.nl.ca/images/PDFs/Evaluating%20the%20Benefits%20-%20NL%20Provincial%20Telehealth%20Program%20-%20Chronic%20Disease%20Mgmt.pdf>
- (9) Sackett DL, Richardson WS, Rosenberg W, Haynes RB. *Evidence-based medicine: How to practice and teach EBM*. New York: Churchill Livingstone; 1997.
- (10) Fragasso G, Cuko A, Spoladore R, Montano C, Palloshi A, Silipigni C, et al. Validation of remote cardiopulmonary examination in patients with heart failure with a videophone-based system. *J Card Fail* 2007;13(4):281-286. DOI: 10.1016/j.cardfail.2007.01.008.
- (11) Mahnke CB, Mulreany MP, Inafuku J, Abbas M, Feingold B, Paolillo JA. Utility of store-and-forward pediatric telecardiology evaluation in distinguishing normal from pathologic pediatric heart sounds. *Clin Pediatr* 2008;47(9):919-925. DOI: 10.1177/0009922808320596.

- (12) Grant B, Morgan GJ, McCrossan BA, Crealey GE, Sands AJ, Craig B, et al. Remote diagnosis of congenital heart disease: the impact of telemedicine. *Arch Dis Child* 2010;95(4):276-280. DOI: 10.1136/adc.2008.146456.
- (13) Huang T, Moon-Grady AJ, Traugott C, Marcin J. The availability of telecardiology consultations and transfer patterns from a remote neonatal intensive care unit. *J Telemed Telecare* 2008;14(5):244-248. DOI: 10.1258/jtt.2008.080102.
- (14) PausJenssen AM, Spooner BA, Wilson MP, Wilson TW. Cardiovascular risk reduction via telehealth: A feasibility study. *Can J Cardiol* 2008;24(1):57. DOI: 10.1016/S0828-282X(08)70550-6.
- (15) Dowie R, Mistry H, Rigby M, Young TA, Weatherburn G, Rowlinson G, et al. A paediatric telecardiology service for district hospitals in south-east England: an observational study. *Arch Dis Child* 2009;94(4):273-277. DOI: 10.1136/adc.2008.138495.
- (16) Dowie R, Mistry H, Young TA, Franklin RCG, Gardiner HM. Cost implications of introducing a telecardiology service to support fetal ultrasound screening. *J Telemed Telecare* 2008;14(8):421-426. DOI: 10.1258/jtt.2008.080401.
- (17) Dowie R, Mistry H, Young TA, Weatherburn GC, Gardiner HM, Rigby M, et al. Telemedicine in pediatric and perinatal cardiology: economic evaluation of a service in English hospitals. *Int J Technol Assess Health Care* 2007;23(1):116-125. DOI: 10.1017/S0266462307051653.
- (18) Löfgren C, Boman K, Olofsson M, Lindholm L. Is Cardiac Consultation with Remote-Controlled Real-Time Echocardiography a Wise Use of Resources? *TELEMEDICINE and e-HEALTH* 2009;15(5):431-438. DOI: 10.1089/tmj.2008.0148.
- (19) Eminovic N, De Keizer NF, Wyatt JC, Ter Riet G, Peek N, Van Weert HC, et al. Teledermatologic consultation and reduction in referrals to dermatologists: a cluster randomized controlled trial. *Arch Dermatol* 2009;145(5):558. DOI: 10.1001/archdermatol.2009.44.
- (20) Romero G, Sánchez P, García M, Cortina P, Vera E, Garrido J. Randomized controlled trial comparing store-and-forward teledermatology alone and in combination with web-camera videoconferencing. *Clin Exp Dermatol* 2010;35(3):311-317. DOI: 10.1111/j.1365-2230.2009.03503.x.
- (21) Pak H, Triplett CA, Lindquist JH, Grambow SC, Whited JD. Store-and-forward teledermatology results in similar clinical outcomes to conventional clinic-based care. *J Telemed Telecare* 2007;13(1):26-30. DOI: 10.1258/13576330779701185.
- (22) Bowns IR, National Co-ordinating Centre for HTA (Great Britain), NHS R. *Telemedicine in dermatology: a randomised controlled trial*: Gray Publishing; 2006.
- (23) Tan E, Yung A, Jameson M, Oakley A, Rademaker M. Successful triage of patients referred to a skin lesion clinic using teledermoscopy (IMAGE IT trial). *Br J Dermatol* 2010;162(4):803-811. DOI: 10.1111/j.1365-2133.2010.09673.x.

- (24) Warshaw EM, Lederle FA, Grill JP, Gravely AA, Bangerter AK, Fortier LA, et al. Accuracy of teledermatology for nonpigmented neoplasms. *J Am Acad Dermatol* 2009;60(4):579-588. DOI: 10.1016/j.jaad.2008.11.892.
- (25) Warshaw EM, Lederle FA, Grill JP, Gravely AA, Bangerter AK, Fortier LA, et al. Accuracy of teledermatology for pigmented neoplasms. *J Am Acad Dermatol* 2009;61(5):753-765. DOI: 10.1016/j.jaad.2009.04.032.
- (26) Edison KE, Ward DS, Dyer JA, Lane W, Chance L, Hicks LL. Diagnosis, diagnostic confidence, and management concordance in live-interactive and store-and-forward teledermatology compared to in-person examination. *TELEMEDICINE and e-HEALTH* 2008;14(9):889-895. DOI: 10.1089/tmj.2008.0001.
- (27) May C, Giles L, Gupta G. Prospective observational comparative study assessing the role of store and forward teledermatology triage in skin cancer. *Clin Exp Dermatol* 2008;33(6):736-739. DOI: 10.1111/j.1365-2230.2008.02850.x.
- (28) Fabbrocini G, Balato A, Rescigno O, Mariano M, Scalvenzi M, Brunetti B. Telediagnosis and face-to-face diagnosis reliability for melanocytic and non-melanocytic 'pink' lesions. *Journal of the European Academy of Dermatology and Venereology* 2008;22(2):229-234. DOI: 10.1111/j.1468-3083.2007.02400.x.
- (29) Moreno-Ramirez D, Ferrandiz L, Nieto-Garcia A, Carrasco R, Moreno-Alvarez P, Galdeano R, et al. Store-and-forward teledermatology in skin cancer triage: experience and evaluation of 2009 teleconsultations. *Arch Dermatol* 2007;143(4):479. DOI: 10.1001/archderm.143.4.479.
- (30) Baba M, Seçkin D, Kapdağlı S. A comparison of teledermatology using store-and-forward methodology alone, and in combination with Web camera videoconferencing. *J Telemed Telecare* 2005;11(7):354-360. DOI: 10.1258/135763305774472097.
- (31) Moreno-Ramirez D, Ferrandiz L, Ruiz-de-Casas A, Nieto-Garcia A, Moreno-Alvarez P, Galdeano R, et al. Economic evaluation of a store-and-forward teledermatology system for skin cancer patients. *J Telemed Telecare* 2009;15(1):40-45. DOI: 10.1258/jtt.2008.080901.
- (32) Ferrandiz L, Moreno-Ramirez D, Ruiz-de-Casas A, Nieto-García A, Moreno-Álvarez P, Galdeano R, et al. An economic analysis of presurgical teledermatology in patients with nonmelanoma skin cancer. *Actas Dermo-Sifiliográficas (English Edition)* 2008;99(10):795-802. DOI: 10.1016/S1578-2190(08)70368-8.
- (33) Pak HS, Datta SK, Triplett CA, Lindquist JH, Grambow SC, Whited JD. Cost minimization analysis of a store-and-forward teledermatology consult system. *TELEMEDICINE and e-HEALTH* 2009;15(2):160-165. DOI: 10.1089/tmj.2008.0083.
- (34) Armstrong AW, Dorer DJ, Lugn NE, Kvedar JC. Economic evaluation of interactive teledermatology compared with conventional care. *Telemedicine and e-Health* 2007;13(2):91-99. DOI: 10.1089/tmj.2006.0035.

- (35) Regional Demographic Profiles, Newfoundland and Labrador. 2007 November. Available at:
<http://www.economics.gov.nl.ca/pdf2007/regionaldemographicprofiles.pdf>
- (36) Nall L, Gulliver W, Charmley P, Farber EM. Search for the psoriasis susceptibility gene: the Newfoundland Study. *Cutis* 1999 Nov;64(5):323-329.