

***Transforming Primary Health Care in Remote Northern Communities:
The Circumpolar Health Systems Innovation Team [CircHSIT]***

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[Note: Proposal has undergone minor changes since its implementation]

1. Rationale

Health care in Canada's North faces considerable challenges with its remote and widely dispersed population, harsh environmental conditions, and thinly deployed health professionals [1]. Despite per capita expenditures that are among the highest in the world, health outcomes continue to lag behind the rest of Canada, and health disparities between the Aboriginal and non-aboriginal population within the North continue to persist [2]. While improving the health of Northerners requires addressing underlying social determinants, transforming the health care system holds promise in the short and medium term. The evidence required to inform a northern-focused and relevant transformation, however, remains to be generated [3]. Our proposal in community-based primary health care (hereafter PHC) is timely and addresses a priority identified by Northerners.

The proposed Circumpolar Health Systems Innovation Team [CircHSIT] builds on substantial prior Canadian-focused research generated over the past decade and responds to recent renewed interest in Arctic issues by the federal government and among Canadians. The Team Leader has recently completed a 5-year CIHR open team grant on circumpolar chronic disease prevention (CTP-79853), which focused on epidemiology, genetics and health promotion. The extension to health systems and policy research is a logical next step. The earlier team grant also fostered the creation of northern-based and northern-led research centres which have now been firmly established and ready to take on leading roles in research [4]. CIHR has been engaged in the development of a northern strategy, and has held two Best Brains Exchanges in Ottawa and Yellowknife during 2011, involving federal and territorial decision makers and several of the co-applicants.

CircHSIT is international in scope. It builds on considerable prior collaboration, particularly the just completed circumpolar health system review [1], which describes the key features of northern health care in 8 Arctic States and identifies cross-cutting themes for further research. Canada can learn from its circumpolar neighbours [5], and vice versa. The recently released report on Canada's strategic role in global health identified circumpolar and Aboriginal health as a Canadian strength and one of five strategic opportunities [6]. The North can learn from the global health research community while solutions developed in the North can benefit other remote regions globally [7].

2. Research Objectives

CircHSIT is designed to provide research evidence to enable the transformation of PHC in remote northern communities in Canada. It aims to achieve this goal through:

1. Reviewing and comparing innovative PHC models in terms of context, system design, policy development, and service delivery in the northern regions of circumpolar countries;
2. Designing, implementing and evaluating PHC interventions and technology innovations to reduce disparities in access and outcomes between northern and southern Canada;
3. Investigating and adapting health facility design, work flow and performance to provide culturally sensitive and clinically effective care;
4. Developing community capacity to contribute to and fully participate in health system improvements;

5. Collaborating with decision makers in health care to ensure rapid translation and application of research outputs;
6. Training the next generation of northern-based researchers and practitioners in PHC-relevant research and sustaining a research-intensive environment in northern institutions;
7. Creating northern-oriented health system performance metrics to inform and enrich the national initiative in patient-oriented CBPHC Network.

Our proposal addresses both research areas specified in the CIHR request for proposals. The entire research program is focused on vulnerable populations in the remote North, where geographical, climatic and human resources constraints have hindered equitable access to appropriate PHC. Within our program, innovative models that are being developed and evaluated are designed with the aim of preventing and managing chronic diseases.

For this application, northern Canada comprises the Northwest Territories, Nunavut and Labrador, where decision makers are actively involved. Some projects will be conducted in Greenland by our collaborators there who will not be funded by the CIHR grant. Other circumpolar countries and regions will be included in comparative policy reviews but no field work will be conducted.

3. Background and Literature Summary

The combined population of the three territories of Canada is just over 107,000, occupying over one-third the landmass of Canada, with a population density of only 0.03 persons per km². The health status, health determinants and health care of circumpolar populations are extensively reviewed in two recent books *Health Transitions in Arctic Populations* [2] and *Circumpolar Health Atlas* [8]. Background and literature that are relevant to specific projects are provided below.

Research framework

In designing this research program, we subscribe to the health systems approach [9] promoted by the World Health Organization and the Alliance for Health Policy and Systems Research. The *health systems thinking* model identifies building blocks which involve numerous domains and jurisdictions. The multi-sector approach is valuable in the northern context where service providers, program managers and policy makers are closely aligned. For clarity we have adopted Remme’s three research domains to strengthen health systems [10], shown below:

<i>Research Domain</i>	<i>Research Focus</i>	<i>Research Users</i>	<i>Research Utility</i>
(A) Operational	Develop solutions to current operational problems of specific health programs/services	Service providers	<div style="text-align: center;">  <p>local</p> <p>broad</p> </div>
(B) Implementation	Scale up available or new intervention and ensure effective integration within health system	Program managers	
(C) Health System	Address system-wide issues and generate lessons for adoption/ adaptation in other settings	Policy makers	

Our projects (described in detail below) collectively contain elements of all three research types, with diversity in design, methods and outcome measures. Projects #1 and #2 can be categorized as (C), projects #4, 5, 6, 8 as (B) and projects #3 and #6 as (A), although the boundaries are not rigid. We align decision-makers with different projects in specific domains so they can help shape research questions and apply relevant results.

Overview of Northern health care system

Northern Canada's system of PHC is based upon a regional network of health centres staffed by nurses with an expanded scope of practice that combines primary care and public health, and supported by secondary and tertiary centres. Vast distances separate communities and hospitals in the North. Including out-of-territory tertiary centres, the North has the most geographically stretched north-to-south network in Canada. Canada's nurse-based system can be contrasted with Alaska's use of community health aides and Greenland's posting physicians in small community hospitals. However, in 2012 Greenland reorganized health care by amalgamating 16 small hospital districts into 5 regions, thus moving closer to the Canadian model [1].

That great health disparities exist is apparent from broad indicators such as life expectancy, infant mortality rates and specific health outcomes [2]. Yet the per capita health expenditures of the NWT are 1.7 times, and Nunavut 2.5 times, that of Canada as a whole [11]. Health care in Nunavut consumes some 30% of the territory's Gross Domestic Product. By comparison, Alaska spends only 1.2 times that of the USA, the northern counties of the Nordic countries are indistinguishable from the rest of the country, and Greenland's per capita health expenditures is only 70% that of Denmark [12]. PHC in northern Canada suffers from underutilization of available technologies and inappropriate use of scarce human resources and expensive transportation services.

On the other hand, Northern health care has also been in the forefront of innovations ahead of the rest of the country. Nurse-practitioners and midwives are not a novelty but have been the backbone of the system for decades. Integrating public health with primary care is another feature of the North that has yet to be widely implemented in the South. The NWT has pioneered an Integrated Service Delivery Model for its health and social services system since 2004 [13]. Although policy innovations regarding health care for Aboriginal people in the Territories have been documented [14], research on how policies have been translated into programs and services addressing priorities across circumpolar regions has yet to be undertaken.

There are major differences in how health care is organized among northern regions in Canada. In Yukon, a variety of funding agreements transfer funding and control of some health services to First Nations. NWT operates a regionalized system with 8 regional health and social services authorities. Nunavut has a centralized system with the territorial government directly providing the full range of services from hospitals to community health centres. In Labrador, Inuit land claim settlement created the self-governing Nunatsiavut region with various responsibilities including health care. The comparative approach taken in our research program will highlight how policy, jurisdictional and governance differences in the organization of health care can influence PHC effectiveness.

Health system performance measurement

Health systems performance measurement provides a mechanism for guiding health system management and improvement, and involves setting priorities, monitoring performance and holding providers and other groups to account [15]. Many frameworks and indicators exist to compare performance at the national, regional, and institutional levels [16]. Although some Arctic states are captured within international initiatives (eg. OECD), their northern regions have not consistently been compared or included in the development of health systems performance measures [5]. Beyond

basic utilization statistics, few measures are outcome related, activity-based, or measure productivity and cost-effectiveness specific to PHC. One useful tool is the balanced scorecard, a management innovation that has been adapted for use in various health care settings [17], but that requires a strong grounding in strategy and context. To date, such an exercise has not been conducted in northern regions and the use of current models may be detrimental to health goals in the North.

Health technology in remote regions

E-health has been touted as the solution to many health care problems of remote areas, and its use has spawned an extensive literature [18]. Circumpolar regions have been world leaders in developing telehealth since the mid-20th century, yet its implementation has been uneven and inconsistent.

The different forms of telehealth practiced in the circumpolar North include real-time interactive consultations, store-and-forward applications, and telemonitoring. Telehealth applications have also provided cost-effective continuing education to health workers in remote locations. Online courses have been used to allow health workers to obtain additional educational credentials.

Implementing and sustaining effective telehealth applications are faced with severe constraints in the North. The equipment at the remote end must be both reliable and simple to use and maintain, given the level of skills available locally and the difficulty of sourcing spare parts. Existing telecommunication infrastructure dictates the type of technology available. In geographically compact countries with government support for broadband deployment, such as the Nordic countries, high bandwidth is readily available in remote areas. Immature network capacity has impeded the development of uniform technology platforms for delivering primary care in northern Canada.

Much progress has also been made in the use of electronic medical records (EMR) in the northern territories, a critical requirement for improved clinical communication [19]. Over 50% of the NWT's population is covered by EMR, which offers an advantage to our proposed research, serving a platform from which different delivery models can be launched and evaluated. Technology alone, however, does not solve health system problems, also required is an understanding of health workflow processes and the ability to manage change effectively [20].

Inter-provider communication

There is an extensive literature conducted in rural/remote settings involving interactions between primary care practitioners and off-site specialists, the use of multidisciplinary teams, telephone triage, centralized dispatch, and other forms of support. A study of telephone consultations between rural GPs and specialists shows that trust is the key element of inter-practitioner communication as it increases understanding and confidence in the reliability of the information exchanged [21]. A systematic review of GP-specialist interactions shows that most physical health outcomes remain unchanged, although patient concordance with treatment tends to improve. Physician behaviour also changes with more rational use of resources and diagnostic tests while clinical skills also improve [22]. A review of continuous and integrated health services in rural/remote areas finds that programs such as managed and integrated care pathways, outreach, shared care and telemedicine may be associated with greater equity in access, more coherence, and greater continuity, although not necessarily reduced costs. A well-functioning PHC system, however, is a prerequisite [23].

Of special relevance to the North is the literature on nursing decision-making [24-26], decision-making between nurses and doctors [27], and collaborative practice [28-29]. Success in primary care collaboration between nurse practitioners and doctors entails responsibility and accountability, co-ordination, communication, co-operation, assertiveness, autonomy and mutual trust and respect

[30]. Nurses and physicians use differing lens to interpret and act on knowledge and in recognizing how knowledge is used to increase collaboration between the two professions.

4. Research Program

CircHSIT’s research program will be conducted in four regions: Northwest Territories (NT), Nunavut (NU), Labrador (NL), and Greenland (GL), with three core components.

<i>CircHSIT: Summary of Research and Training Program</i>			
Research Projects	Regions/Sites	Methods	Activities/Outcomes
<i>Part One: Exploring Policy Options and Assessing Health Systems Performance</i>			
“What policies have circumpolar health regions developed to improve access to high quality, responsive PHC and have they achieved their objectives in terms of health outcomes, quality of care, efficiency in resource use, and equity among and within regions?”			
#1. Comparative analysis and exploration of PHC policy and practice options	NT, NU, NL, GL	Multiple case study: document analysis, key informant interviews	Review policies, document experiments and innovations, analyse context in which policies emerged; explore findings with decision-makers and develop alternatives
#2. Measurement of circumpolar health system performance	NT, NU, NL, GL	Systematic review, consensus process with community validation	Design measurement scheme; identify need for measures specific to indigenous people; produce balanced scorecard on PHC in the 4 regions
<i>Part Two: Developing Innovations in Primary Health Care Delivery</i>			
“What can be done to improve PHC services at critical points in the patient’s pathway through the system?”			
Pre-Encounter: “How frequent and serious are medical emergencies occurring away from the community and what can be done to prevent them and improve outcomes?”			
#3. Response to medical emergencies away from community health centres	NU, NL	Review of health centre records and coroners’ reports; key informant interviews	Assess frequency, severity and spectrum of emergencies; develop strategies in consultation with stakeholders to improve outcome
Encounter: “Can health facility design and use of technology improve efficiency, effectiveness and cultural sensitivity in the delivery of primary care services?”			
#4. Alternative models of health care architecture in northern PHC	NU, NL and GL	Visualization of spatial relationships; community workshops	Develop and present models; recommend design changes to improve efficiency of care and respect for local culture
#5. Creation of territory-wide chronic disease registry for monitoring clinical care	NT	Automated inference rules in structured data from electronic medical records	Create registry of selected chronic diseases, evaluate impact on continuity of care and adherence to clinical guidelines

#6. Use of remote presence technology in chronic disease management	NL	User survey, medical records review, cost analysis, participant observation	Demonstrate operational feasibility, reduced patient transportation costs, improved adherence to clinical guidelines and patient outcomes
Post-Encounter: “Can inter-practitioner communication improve patient triage and reduce unnecessary transfer out of community?”			
#7. Frontline providers’ perspectives on medevac decision making	NU, NL, GL	Key informant interviews; participant observation	Understand how medevac decisions are made and the nature of the collaboration between health centre nurses and regional hospital physicians; identify contextual factors which affect the decision process
#8. Evaluation of referral and transfer systems from communities to regional hospitals	NT, NU, NL, GL	Medical record review, mapping and mobility models, economic evaluation	Modify management practices and establish standards of care, transportation protocol and central dispatch system
Part Three: Building Capacity for Northern-Based Health Systems Research			
“How do we create an environment for long-term commitment to health research in the North?”			
#9. Northern-based training of graduate students	NT, NU, NL, GL	Scholarships, practica placements, summer institutes, mentorship by research team	Create cadre of committed students; enable career path in northern based health system research; promote interest in north among broader student body
#10. Development of northern-based research faculty	NT, NU, NL		Consolidate existing northern-based health research centres; advocate for faculty appointment for northern based researchers

While the different projects are intended to be conducted in parallel and not sequentially, the first two projects will inform the others, especially in designing new studies that will emerge during the latter part of the 5-year grant period. Additional research grants from CIHR and other agencies will be pursued. This team grant will develop CircHSIT into an international consortium of researchers and northern decision-makers well positioned to advance knowledge to address critical health systems concerns.

Part One: Exploring Policy Options and Assessing Health Systems Performance

(1) Comparative analysis and exploration of policy and practice options

Rationale: Providing equitable access to PHC in remote northern communities is an on-going challenge for policy makers. Better access to a broad range of PHC services is associated with improved outcomes for a variety of health conditions [31,32]. The context in which PHC policies have emerged in the North has been little studied [14]. Northern health agencies are engaged in

experimentation and innovation to better meet community needs in culturally appropriate and responsive ways. These models are often localized, designed to respond to local priorities, and may only be partially or not implemented at all. The lessons learned are rarely disseminated. While forming a substantial proportion of the regional population (30% in Labrador, 50% in NT, and 85% in NU and GL), Indigenous people have unique cultural needs that challenge the responsiveness of biomedically oriented health care systems and therefore must be accommodated.

Objectives: (1) Document, compare and analyse the policies on PHC in circumpolar regions to meet the needs of residents in remote communities, in particular Indigenous people; (2) Conduct a strategic mapping of policy and innovation within PHC systems; (2) Identify lessons for Canada and explore potential policy alternatives for improvement in PHC services.

Methods: Key areas for comparison among regions will be selected via a consensus process involving researchers, decision-makers and clinicians. We will use a multiple case study design, in which a case study is one region [33]. For each region we (a) identify contextual factors influencing policy and health system design; (b) map PHC options and how they reflect governance and models of care; (c) document experiments and innovations to expand equitable access to culturally safe and responsive care for Indigenous peoples; and (d) link the results to policy. We will conduct policy and document analysis and interview policy-makers, providers and representatives of Indigenous organizations. We will use a descriptive phenomenological framework to inform the gathering of data and its analysis.

Outcomes: By systematically documenting local initiatives and mapping out their contribution to sustainable, responsive and equity-oriented PHC, this project will fill a major gap in knowledge, and provide an invaluable resource which other regions can draw from. In keeping with the principles of Integrated KT, we plan to bring together decision-makers from each region to explore critically the findings and their applicability to PHC improvements. We expect that these meetings will validate our analysis, and may generate ideas about hybrid models and policies to overcome existing shortcomings. These cross-jurisdictional knowledge exchange may result in more refined PHC models to be further researched, perhaps as interventions during years 3-5 of the research program.

(2) Measurement of circumpolar health systems performance

Rationale: Little is known about how circumpolar health systems perform and compare with one another. A set of indicators that can be consistently applied across jurisdictions is needed to provide a supportive framework for management decisions, policy development and PHC improvement.

Objectives: (1) Identify the tools that have been used for performance measurement (frameworks, indicators, and reporting formats) in circumpolar regions; (2) Assess their comprehensiveness and need for indicator development that is specific to the circumpolar region, particularly the Indigenous populations; (3) Based on collected performance indicators, produce a balanced scorecard on PHC performance across the four northern regions.

Method: (1) Conduct a systematic review of the published and grey literature; (2) A modified Delphi process will be used to identify data needs, sources and limitations. Focus groups of community representatives will be constituted to review the indicators and assess their relevance. The need for unique indigenous-specific indicators that are culturally appropriate and capture the perspectives of indigenous people will be explored; (3) Produce balanced scorecards populated with indicators that align with and describe the relationships between dimensions of the PHC systems.

Outcome: A balanced scorecard on PHC in the four regions will be used by decision makers to inform strategic planning and quality improvement in PHC. This project will be closely linked to, and compatible with, the proposed national Patient-Oriented CBPHC Network.

Part Two: Developing Innovations in Primary Health Care Delivery

In planning this component of the research program, we identify critical intervention points along the patients' pathway to care, in the pre-encounter, encounter, and post-encounter phases.

(3) Response to medical emergencies away from community health centres

Rationale: Residents in remote communities do not have access to emergency medical services. Although health centres exist in most communities, homes can be widely scattered and transportation not always available. Many northerners are engaged on the land hunting, trapping and fishing, which may be hours away from professional help. Little is known about the extent of the problem, the community's views, and culturally relevant and geographically appropriate solutions. The dangers of land-based activities are increasing due to climate change (through its impacts on ice and bush trails, and weather unpredictability) and changing traditional knowledge systems. Many Inuit youths lack traditional land skills, which is reflected in increased accidents [34,35].

Objectives: (1) Determine the extent of the problem, the type of conditions encountered, and the outcomes; (2) Examine components of risk avoidance, preparedness, and management which influence the occurrence and character of medical emergencies, and (3) Consult stakeholders to develop prevention strategies and improve outcomes.

Method: There are multiple sources of data on medical emergencies occurring away from the community - health centre visits, coroner's database, and newspaper reports. Elders and hunters will provide narratives of their journeys to reach care and the actions taken before help is available. Traditional knowledge has a key role in individual decision making in land-based activities. It affects risk taking behaviour, the ability to locate and avoid risks, and respond to dangers when they occur. Many Aboriginal people possess detailed knowledge of 'wilderness medicine'. Interviews, focus groups, and participant observation methods will be used to document and characterize the role of traditional knowledge in avoiding and responding to on-the-land emergencies.

Outcome: "Bush courses" can be designed to train community members to handle emergencies. First aid courses cannot be simply transplanted to the North. The Northern Ontario School of Medicine has pioneered a wilderness emergency response education course in a remote First Nation [36], which we shall consult. Teachers will comprise community elders and emergency medicine professionals. The communities will fully participate in the planning, implementation and evaluation phases of such courses. We will also work with community members to undertake interventions to address the increasing erosion of traditional knowledge and land skills across the north.

(4) Alternative models of health care architecture for northern PHC

Rationale: The architecture and interior design of health centres in the North have traditionally not been contextually, culturally and ecologically sensitive [37]. While there is an emerging literature on the impact of design on health care spaces and facilities, little research or documentation have been conducted in the Canadian North that recognize traditional Inuit, Dene and Innu culture and actually embrace the extreme environment characterized by prolonged periods of cold and dark.

Objectives: (1) Explore alternative models of care based on architecture and health infrastructure that integrates the unique geography, climate and culture of the North. (2) Develop relevant spatial/building typologies that integrate emerging technology, cultural specificity, and site-specific factors. (3) Visualize a health care architecture specific to the North.

Methods: Three communities, one each in NU, NL, and GL, will be selected: (1) Workshops will be held with northern based architects and engineers, facility managers, service providers, and health

care users to review existing designs and propose modifications; (2) Large-scale models will be developed to visualize how architecture and infrastructure can impact treatment, access, and well-being and what long-term modifications can be made to overhaul the system; (3) Small-scale experiments will be initiated to test new design features relating to rooms, spatial organization, and technology innovations and their impact on the clinical encounter. This research will be guided by harmonizing contemporary and indigenous practices of sustainable architecture and health care.

Design studies will be documented through visualization using 3D modelling software (such as Rhino, CAAD, and Eco-Tec), as well as physical architectural scale-models, which are more accessible in a workshop/collaborative context.

Outcome: Proposals will be made to decision-makers to incorporate modifications in infrastructure and facility design into planning for future capital projects within the regions.

(5) Creation of territory-wide chronic disease registry for monitoring clinical care

Rationale: Chronic diseases are an emerging health problem in the North, especially among Indigenous people undergoing rapid health transition. Its prevention and control has been identified as a high priority by the government. The NWT has embarked on an ambitious plan to implement a pan-territorial electronic medical record (EMR) system that can serve as a repository of all patient health care data. A chronic disease registry will improve case management, and can be constructed based on patients' problem lists in the EMR. However such problem lists are often incomplete, especially in a setting with high physician turnover and reliance on locums.

Objectives: (1) Create an EMR-based alerting system to improve notation of chronic diseases in patients' problem lists; (2) Develop a chronic disease registry from patients' problem lists; (3) Monitor and evaluate quality of care of patients with chronic diseases identified from the registry.

Methods: We shall adapt the automated digital inference rules developed by Wright and Adam in Boston [38] for selected chronic diseases for the NWT, with technical support by our industry partner Telus Physician Solutions. These rules, based on medications, lab results, and diagnostic codes, trigger an alert to the physician to add a chronic disease to the electronic problem list. A randomized trial in Boston area hospitals demonstrated physician compliance with the alerts and improved completeness of problem lists [39]. We shall randomize 22,000 patients in the NWT EMR system, with one arm allocated to receive the alerts compared to controls. The number of alerts triggered and the proportion accepted by the physician and entered as a problem will be monitored over a 12-month period. The primary outcome measure is the absolute difference in additional problems via the alerts between the intervention arm and controls.

If the alert system adds significantly more chronic disease notation in patients' problem lists, the next step is to use the problem lists as the basis for a chronic disease registry. In the second half of the 5-year grant period, the quality of care of chronic disease patients will be monitored and evaluated based on measures such as frequency of diagnostic procedures, referrals to specialists, hospital admissions for acute complications, and disease-specific laboratory indices (blood pressure, plasma glucose and glycated haemoglobin levels, etc).

Outcomes: Our study will replicate the Boston study [39] in a different clinical setting and population, and thus tests the generalizability of the methodology. The alert system is particularly suited for the NWT where there is a very high physician turnover and dependence on short term locums, as it provides system continuity. The electronic problem lists form a de facto disease registry, from which quality of care can be monitored and improved. Other applications include clinical decision support,

epidemiologic surveillance, and generation of cohorts for research. Labrador has also indicated an interest in extending the study to its region in Years 4-5.

(6) Use of remote presence technology in chronic disease management

Rationale: Staffing of remote health centres continues to face shortages, high turnover and lack of continuity, affecting accessibility to and quality of PHC, particularly non-urgent services such as prevention and control of chronic diseases. The use of remote presence technology (telerobotics) can offer consistent physician presence on-site to deliver services, freely interacting with patients, families, and outpost nurses, unaffected by weather interruptions and dependence on short-term locums, resulting in reduced travel time and costs for patients and physicians.

Objectives: (1) Replace current episodic management of patients by visiting physicians with a robot installed at the health centre controlled by a designated physician at the regional centre; (2) Evaluate technology in terms of access, quality, acceptability, cost-effectiveness, and clinical outcomes.

Methods: The project will take place in Labrador, where the robot is already located at the health centre in Nain (population 1500) and the regional physician is based in Goose Bay. The community-owned robot (nicknamed Rosie), designed by In Touch Technologies, consists of a movable body with a fully rotating flat computer screen as “head”, a zoom camera, and connection to monitoring equipment such as EKG, ultrasound, etc. It is controlled by the physician via a laptop computer with 2-way audio, and whose face appears at the robot’s screen.

The robot will be used for clinical management of chronic disease patients in Nain, who are followed-up by a visiting physician from Goose Bay, and airlifted to hospital for acute complications. The technology will be evaluated over a 12-month period in terms of frequency of use, transfer avoided and costs saved, waiting time for physician referral, quality of diagnostic information transmitted, provider and patient satisfaction, impact on nursing workload and workflow, compliance with clinical guidelines, key lab indices, and rate of adverse outcomes. The pre-post design will be used, and comparison with a “control” community without the robot.

Outcome: Rosie the Robot was first piloted tested in Nain in 2010-2011. Originally used for management of medical emergencies, its use is being expanded to other areas, of which chronic disease management has been identified. Pending a positive evaluation, decision makers will be presented with the evidence, who may decide to replace/supplement the existing system of infrequent and irregular visiting physician clinics with telerobotics.

(7) Frontline providers’ perspectives on medevac decision making

Rationale: A nurse in a community health centre consults a physician in a regional hospital regarding patient management and the need for transfer. Collaboration, consultation, and clinical judgement are integral to decision-making about referrals, especially medevacs with their associated high costs. Little is known about the decision-making process among frontline providers, which is key to any strategy aimed at reducing unnecessary referrals.

Objectives: (1) Understand the medical decision-making process between community health nurses and regionally based physicians and explore the nature of inter-professional collaboration and consultation; (2) Identify the contextual factors that influence the decision to evacuate a patient.

Methods: The multiple case studies method offers depth, flexibility, versatility and manageability [33]. Three communities in NU, NL and GL will be selected to illuminate contextual differences and similarities: road-access or air-access only, population size, and distance from regional hospital.

Within each case data will be collected from individual interviews, group meetings, chart audits, document review, and participant observation.

Participants will be recruited within each community through purposive sampling, starting with the nurse-in-charge of a health centre. Other informants include medical travel clerks, airline agents, ambulance attendants, and physicians in the hospitals. The interviews will begin with a story about a medevac experience to help frame what happens in the community and to highlight the decision-making process. The semi-structured interview will continue following a guide. Two group meetings will be held with the nurses to gain their perspective. In each health centre, retrospective chart audits (n=20) will be performed on medevacs within the past 5 years. Procedures and guidelines used by nurses and GPs will be reviewed and summarized. Participant observation in the health centre will be written as field notes. A journal will be maintained to reflect on the research and its progress.

Outcome: Research results will be communicated to decision-maker partners in the regional health authorities and territorial health department. Senior health system managers have been grappling with escalating costs of medevacs and are currently engaged in streamlining the referral and evacuation system, providing clear policies and clinical guidelines, and promoting inter-professional communication across all levels of the health system.

(8) Evaluation of referral and transfer systems from communities to regional hospitals

Rationale: High staff turnover, lack of explicit protocols and clinical inexperience at both ends of the consultation result in a high volume of medevacs from the communities to regional hospitals, many of which are deemed inappropriate or unnecessary. The costs are also social. Patients, including expectant mothers, are separated from their familial support networks, sometimes for extended periods. With the use of telehealth technologies, appropriate training, explicit guidelines, and a designated dispatch service, many medevacs could be delayed and scheduled flights used instead, while many non-urgent transfers can be avoided altogether. Telehealth consultations have been shown in Labrador to be economically beneficial and satisfactory to patients and providers [40].

Objectives: (1) Describe the current referral and evacuation patterns; (2) Identify and quantify avoidable transfers; (3) Conduct economic evaluation and present different options.

Methods: This project will track referral patterns over a 5-year period in the 4 regions, perform geo-spatial mapping of the volume of transfers, build mobility models, and estimate the associated costs. The reason for transfer and for hospitalization will be examined for all diagnoses and selected “ambulatory care sensitive conditions” (ACSC) which are responsive to PHC interventions [41]. Avoidable hospitalizations for ACSCs have been used in access and quality of care studies internationally and in remote First Nations [32]. The evaluation will also audit a sample of patients who are not transferred. Thus we determine both the proportion of patients who are transferred but should not have been, and the proportion of patients who are managed locally but should have been transferred. The Canadian Triage and Acuity Scale [42] will be used to classify patients. Regional differences will be linked to differences in policy and models of organization and service delivery.

Economic evaluation will be based on estimates of the use of human resources, transportation, hospitalizations and other costs following the care pathways of patients. We will also determine the incremental costs or savings by simulating various scenarios based on alternative options in technologies or practices to reorganize the referral and transfer system.

Outcomes: Results of the project will inform the NWT government’s design of its Territorial Support System (TSN), which involves a central dispatch for all transfers, harmonizes clinical and transportation protocols, and enhances communication among providers. The project will provide

the baseline upon which the program will be evaluated in the future. TSN could serve as a model for decision makers in the other regions to improve management practices and standards of care.

5. Work Schedule

Assuming an April 1, 2013 start, Year 1 (2013/14) will be devoted mainly to detailed planning and further consultations with partner agencies. A full team meeting will be scheduled within the first 3 months from the flow of funding. The regional coordination centres in Yellowknife, Iqaluit and Goose Bay will be organized, additional staff hired, and sub-grants initiated. Teams for individual projects (#1-8) will be assembled, who will be responsible for additional community consultations, institutional ethics approval and application of territorial research licenses.

Implementation of individual projects will occur from Year 2 (14/15) to Year 4 (16/17), with staggered start and end dates. Projects will be regionally organized, sharing research and clerical support staff. Throughout there will be regular briefing of partner agencies. Graduate student training (#9) and faculty development (#10) will occur throughout the 5 years. There will be a call for graduate fellowships in Year 1 and biannually thereafter. Annual conferences will bring together all team members and partners for progress reports, generation of new ideas, and dissemination of early results. Year 5 will be for data analysis of most projects, preparation of final reports, and also planning of renewal of the team grant and new project proposals for additional funding.

6. Nature of the Team and Environment

Our research team is composed of seasoned researchers and knowledge users with a complementary mix of broad knowledge of northern health care, front-line experience, specific content expertise, and close and long-standing past collaboration. The team is multidisciplinary and multijurisdictional.

Researchers: The team will be led by **Kue Young**, an internationally recognized researcher in northern/Aboriginal health, who has led three major CIHR teams since 2001. He co-chaired the Arctic Council's Human Health Expert Group. While health services research has not been his field and this grant represents a new direction, he is supported by other experts in the team. **Josée Lavoie** has done extensive research in indigenous controlled PHC in Nunavut and western Canada. Her research focuses on sustainable PHC, using technologies to improve access, and community engagement in health planning, policy, and service delivery. **Arto Ohinmaa** is involved in health care performance comparison between 6 Canadian provinces and 7 EU countries. Originally from northern Finland, he shall bring a Nordic perspective to the team. We shall build on **James Ford's** previous work on land-based hazards and link into his CIHR-funded project to document, conserve, and promote traditional Inuit knowledge for adapting to the health effects of climate change. **Mason White** investigates an architecture that is responsive to climate change and social inequality, with award-winning designs in cold-climate architecture, social infrastructure and sustainable construction. He has worked on visualization and community consultation models for design projects in Nunavut. **Adalsteinn Brown** came to academe from the Ontario government, where he was Assistant Deputy Minister of Health and also of Research and Innovation. He has assessed health system performance both in Canada and in Europe.

Our team is strengthened by the inclusion of emerging northern-based researchers. **Susan Chatwood** and **Gwen Healy** are, respectively, founding directors of the Institute of Circumpolar Health Research (<http://ichr.ca>) in Yellowknife and the Qaujigiartiit Health Research Centre (www.qhrc.ca) in Iqaluit, who have worked with northern partners to increase research capacity. Both are currently enrolled as PhD students at the University of Toronto.

Knowledge Users: Bridging decision-makers and researchers is **Michael Jong**, a senior health executive and past president of the Canadian Society of Rural Physicians, who has evaluated telehealth applications in Labrador. **Ewan Affleck** is a longtime family physician in the North who has pioneered EMR and other eHealth programs in the NWT and advocated for reform of community-based PHC. **Robert Nevin**, a nurse-administrator who directs a family practice clinic, offers both clinical and administrative perspectives to PHC in a territorial capital. **Lisa Cardinal**, in charge of planning and evaluation in the NWT health department, has been tasked to evaluate the Integrated Service Delivery Model and thus will contribute valuable data to our research.

Partners: The Partner Table lists the CEOs of regional health authorities and deputy ministers of health from the 4 regions who have provided letters of support. They have assigned key senior staff to our team but will also personally monitor the progress. An industry partner provides technical support to project #5. The Grand Chief of Dene Nation also provided a strong letter of support.

International Collaborators: The Canadian team is joined by **Peter Bjerregaard**, who has a long career in health care and research in Greenland. He helped draft its Public Health Strategy and is an advisor to Greenland's health care reform launched in 2012. Now based in Norway, **Richard Wootton** has long experience researching telehealth globally and is the founding editor of the *Journal of Telemedicine and Telecare*. **Adam Wright** (medical informatics) and **David Bates** (internal medicine) at Harvard Medical School developed the automated inference rules and are keen to replicate the method in a different setting, which coincides with our plans for a chronic disease registry in NWT.

Our team members' strengths are complementary and each plays a specific role in one or more projects. There is considerable cross-over between "knowledge users" and "researchers". The former will actively participate in the research, and liaise with the CEOs and deputy ministers who have assigned them. There will be regular briefings of the major health agencies in the four regions.

Team Management and Coordination: CircHSIT operates under the collegial rather than hierarchical model, with a flexible administrative structure and collective decision-making. While the grant is under the oversight of the Toronto-based team leader, the research will be coordinated in the North, at Yellowknife, Iqaluit and Goose Bay. A project coordinator will be hired to provide administrative support. Each centre will be allocated a sub-grant to administer and will be involved in data collection, management and analysis, and consultation and liaison with northern governments and non-governmental agencies. They also serve as staging points for projects implemented further afield in remote communities. The entire team will meet annually, rotating among the northern sites, and also occasionally at special symposia and workshops. A core group consisting of the NPA, Principal Knowledge User (PKU), co-PA and staff will meet quarterly by tele- and video-conferencing. Both the NPA and PKU will make regular administrative visits to the northern sites to promote CircHSIT among stakeholders and the general public.

7. Capacity Development, Training and Mentorship

CircHSIT goes beyond the execution of a suite of research projects and aims to leave a legacy in research infrastructure and capacity development in the North.

Institutional capacity: We deliberately attempt to strengthen the northern research centres, the Institute for Circumpolar Health Research [ICHR] and Qaujigiartiit Health Research Centre [QHRC], by diverting the main grant to them to manage. While both have had successfully managed grant funds, the team grant will be a new and important experience in terms of scale and scope. ICHR became CIHR-eligible in 2012, a first in Canada "North of 60". Their involvement in CircHSIT reinforces the new model for northern health research, which has evolved from the

traditional role of research facilitation and community liaison to one of the actual design and implementation of research projects, in collaboration with partners from outside the North

Learning environment: Graduate students and postdoc fellows working in specific projects will benefit from the rich environment of researcher-decision-maker interactions. We will offer shorter term (<12 months) practica in northern agencies and Aboriginal organizations to expose students to “real world” experience and acquaint them with community priorities and sensitivities, while strengthening the research capacity of the hosts. We will recruit health professional students for summer projects to promote health research as a career choice. Team-funded trainees will attend annual workshops as a form of shared common learning.

Faculty development: Our proposal is unique in specifying mentorship for northern based faculty members. ICHR set a precedent in signing an affiliation agreement with the University of Toronto and its director has a status-only faculty appointment. We shall assist QHRC towards the same goal. Memorial University already has a full-time faculty based at the Labrador Institute in Goose Bay. Northern-based faculty can be mentored by senior faculty in the team to become supervisors of graduate students and further their skills in grantsmanship. Health professionals who are involved in our research will be motivated to acquire research training to become clinician-scientists.

8. Knowledge Translation

Research dissemination: CircHSIT will use and produce different types of information for other researchers, practitioners, decision-makers, and the public in northern communities, utilizing the scientific literature, policy briefs, and the media. The team grant will support the Circumpolar Health Observatory, which is a repository of health statistics and government documents for 27 regions in 8 Arctic countries. As our research progresses, new materials will be added to CircHOB. The University of Manitoba Health Sciences Library will be contracted to provide outreach service for northern administrators, practitioners and researchers, whose effectiveness and opportunities for continuing education are hampered by the lack of access to university libraries. The service will include literature searches and document delivery, and on-line training/advice on searching databases. CircHSIT will support financially the *International Journal of Circumpolar Health*, an open access peer-reviewed online journal as the main venue to publish special issues and workshop proceedings resulting from our research.

Research-to-action: Taken collectively, our projects encompass needs assessment, policy review, program evaluation, and intervention trials, and at every stage there will be feedback through the decision makers on our team to our partner agencies. Our team will also establish strong links with northern health workers and involve them in the planning and organizing of our periodic scientific events. Our research addresses operational issues, scales up effective interventions, and aims to promote system changes. CircHSIT will be a vehicle for northern health agencies to access evidence-based policy advice. We will help develop a northern Cochrane Collaboration site for systematic reviews on issues relevant to the North and adapting them to northern/Aboriginal populations.

9. Ethics

This proposal will undergo ethical review by the University of Toronto. All research in NT and NU require a research license issued by, respectively, the Aurora Research Institute and the Nunavut Research Institute, under the *Scientists Act*. The licensure includes a community review to ensure ethical compliance and reporting back to communities, which meets many elements of the Tri-Council guidelines for research involving Aboriginal peoples. Individual projects will apply for a research license from the relevant jurisdiction. While Aboriginal people constitute 50% of the population in NT and 85% in NU, the territorial governments are public governments and the health care system is regionally organized and not ethnicity-based (unlike First Nations health

systems in the provinces). As many regional health authorities are Aboriginal led and serve predominantly Aboriginal communities, health care issues with special relevance to Aboriginal communities will be managed through their regional consultation and decision-making processes.

In Labrador, the Inuit land claims agreement created the Nunatsiavut Government (NG) with its own health department and a process for research approval, which we shall follow. The Stanton Territorial Health Authority (STHA), which serves the entire NWT in secondary hospital services, has an Elders Council representing all regions. Through a memorandum of understanding between STHA and ICHR, the Council will provide advice to researchers, safeguard Aboriginal values and cultural integrity, and provide feedback on research relevance and benefits. In self-governing Greenland, research is regulated by a Commission of Research with broad representation.

Regarding the research projects, we do not anticipate any ethical concerns beyond individual consent to interviews and safeguarding privacy and confidentiality in the use of anonymized health databases.

10. Anticipated Outcomes and Impact

Northern jurisdictions face tremendous health care challenges. The lessons learned from our research program will provide decision makers the evidence and tools to improve health outcomes and patient satisfaction while reducing costs. The PHC performance indicators specific to northern conditions will contribute to the pan-Canadian initiative of the Patient Oriented CBPHC Network.

We anticipate our research outcomes to be generalizable from the four study regions to other northern and remote communities in the provinces. Internationally, beyond the circumpolar countries, developing countries with scattered, far-flung communities (islands, oases, outposts, etc) can also benefit from some of our findings. Successful innovations, eg. emergency response (#3), health space design (#4) and telerobotics (#6) lend themselves to scaling up from pilot to system change and replication in the other regions. Projects where options are evaluated and compared (#8 on referrals), policy makers will be able to make informed choices as to which will be feasible and implemented. The method to create disease registry from problem lists in EMR (#5) is readily applicable to other regions at low cost. Project #7 may help identify underlying causes of provider dissatisfaction and high turnover and inform human resources recruitment and retention strategies.

Our most important legacy will be the strengthening of northern based research capacity and the development of the next generation of researchers with exposure to everyday health system challenges. Decision makers who are our partners will also gain an understanding of the rigour of research and the importance of evidence in policy development and program design.

Measuring research impact is a relatively new field [43] and evolving methodologies exist that go far beyond the counting of citations. We intend to collect data on the 5 categories of research impact indicators recommended by the Canadian Academy of Health Sciences [44] - advancing knowledge, capacity building, informing decision-making, health, social and economic impacts - as an integral part of our research as it proceeds and not only as an afterthought after the research is done.