

Creating a Sustainable Health Research Industry in Northern Ontario

Appendix 4: Background Briefing Book – Background Information on the Health Research Industry in Northern Ontario

April 27, 2005



**Northern Ontario
School of Medicine**

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THE PURPOSE OF THIS DOCUMENT

Context

This document is prepared as part of a project, commissioned by the Northern Ontario School of Medicine together with a number of key stakeholders in Northern Ontario and carried out by SHI Consulting. This project's purpose is to develop a practical, implementable strategy for the expansion and development of the health research industry in Northern Ontario with the objective of creating additional employment opportunities in the region.



What this document is

This document is a Briefing Book. Its purpose is to provide background information on Northern Ontario and a number of aspects of the health research industry in the region. This is intended as a basis for discussion and to stimulate thought among the participants in a series of consultation meetings being held across Northern Ontario in early May 2005. These meetings are intended to generate input into the strategy generation process from stakeholders and to give the opportunity for parties who wish to drive the creation of such an industry in the region to come to the fore.



What this document is not

This document is not a report on the outcome of a consulting engagement. It is not intended to draw conclusions and is not indicative of the final strategy to be developed and implemented. It is also not comprehensive, but forms the basis for discussion and identification of further information and ideas. If you read this document and find that key initiatives and important information relating to health infrastructure and research in Northern Ontario are not mentioned, please raise this during the consultation session to be held in your city.



In conclusion

The authors of this document invite you to participate, think, debate, raise issues and contribute as much as possible to this process. The outcome of this work should be economic and employment growth in your region. The more you are able to contribute to it, the more successful the outcome will be.

EXECUTIVE SUMMARY

NORTHERN ONTARIO – REGIONAL CAPACITY

The first section of this document covers general regional capacity to brief the reader on the existing economic landscape within which a Health Research Industry will have to be grown. This is important to know to understand what strengths and weaknesses lie in the general economy beyond the specific industry this document targets.

Demographics and Industries:

Northern Ontario is home to 524,000 people or 4.6% of the total for Ontario. The population decreased 5% from 1996 to 2001. Average unemployment is 9.4%, versus 6.1% for the whole province. Northern Ontario sustains over 300,000 jobs. The largest industries by employment are: retail trade; healthcare and social assistance (13% of all jobs); manufacturing and accommodation & food services. Some research-oriented life science companies are already present.

Infrastructure and Initiatives:

A number of key assets already exist off which to leverage. Tertiary educational institutions include: Northern Ontario School of Medicine; Laurentian University (Greater Sudbury); Algoma; University College (Sault Ste. Marie); Lakehead University (Thunder Bay); Nipissing University (North Bay); Sault College of Applied Arts and Technology and Confederation College.

Many health facilities exist and several are already engaged in research. There are over 40 hospitals in Northern Ontario with a total of 3563 public beds. There are also multiple research centres and lab facilities.

IDENTIFYING OPPORTUNITIES WITHIN THE HEALTH RESEARCH INDUSTRY

There are multiple opportunities which Northern Ontario could pursue that would build on its specific strengths, including preclinical research in the basic sciences, research into disease prevention and therapy, research on how best to provide health services in rural areas and for Aboriginal peoples as well as health information systems, including telehealth.

Basic Sciences:

Northern Ontario has strengths in mitochondrial DNA research and certain basic research into types of cancer.

Disease Prevention and Therapy:

Northern Ontario has higher rates of some conditions than the province as a whole, such as cardiovascular disease, cancer, respiratory disease and injuries. These areas can be concentrated on for clinical research and trials. There is already clinical trial expertise in the region on which to build.

Health Services (Rural and Aboriginal Populations):

This includes studies of health issues specific to more remote locations, including preventive healthcare and health delivery. There is already a Centre for Rural and Northern Health Research.

Health Information Systems:

These are systems used to aggregate, store, transmit and access data by health professionals. Current examples include: NORad, Northwest teleradiology system hub; electronic Child Health

Network (eCHN); North Eastern Ontario Network (NEON); Group Health and Northern Diabetes Health Network (NDHN).

ENABLERS OF GROWTH FOR THE HEALTH RESEARCH INDUSTRY IN NORTHERN ONTARIO

There are five key components to a successful life science research industry cluster: innovative scientific research; commercialisation mechanisms, capital, human resources and physical infrastructure.

Canadian Investment in Big Science (Infrastructure & Programs):

These are multidisciplinary 'mega-projects' that bring together many experts and require sophisticated infrastructure. Such initiatives include Networks of Centres of Excellence (NCE), Genome Canada, the Canada Foundation for Innovation (CFI), and the National Research Council (NRC).

Human Resource Development (Science and Technology Skills):

Health science depends on highly qualified personnel. Many of the right skills are taught at tertiary level in Northern Ontario, which will be further strengthened by the opening of the new medical school. Building up the health research industry in the region will offer opportunities to skilled people so that they do not migrate out of the region to pursue their careers.

Intellectual Property and Commercialization Strategies:

Strong protection of intellectual property (IP) and assistance to commercialise academic research into real healthcare products are important pillars for this industry. The new medical school has the opportunity to adopt international best practice IP policies that could make it unique in Canada, thus attracting high-quality researchers.

Financial Resources (Grants, Venture Capital, Tax Incentives):

Public funding for health R&D in Canada has increased significantly in the past 6 years. In 2003, just over \$5 billion was spent in Canada on health R&D. In 2004, Canadian venture capitalists (VC) invested \$445 million in health-related industries, 25% of all VC investment that year. 45% of this was in Ontario. Northern Ontario recorded a total cumulative investment of \$20.4 million from 1996 to 2003 across all sectors.

OVERVIEW – DEFINING KEY AREAS OF IMPORTANCE

This briefing book is structured on a framework of three sections, namely:

1. Regional capacity in Northern Ontario
2. Opportunity identification within the Health Research Industry
3. Enablers of Growth for the Health Research Industry in Northern Ontario

Within these three sections, 10 key areas of importance are covered, which were selected by members of this project's advisory committee.

The first section is covered to give the reader an understanding of the baseline regional capacity to grow an industry. This gives general demographic, industry and infrastructure information that moves from the general to the specific. This gives the reader context within which to understand the requirements to build a health research industry.

Having understood the context, the second section takes the reader through some of the areas of opportunity that exist for this industry in Northern Ontario. There is a spectrum of opportunity, some of which are more appropriate for Northern Ontario than others, so that strengths can be built upon to ensure the greatest level of success.

Having given this level of understanding, the third section covers some detail on some of the enabling factors for a health research industry. These would form the building blocks for this industry, to offer it the maximum chance for growth in the region.

Each of these areas is explored in a lot more detail. The reader may choose to get an overview from the executive summary and then to go into detail in any of the sections of particular interest to her or him.

NORTHERN ONTARIO – REGIONAL CAPACITY

DEMOGRAPHICS AND INDUSTRIES

Demography

The North Ontario region is home to more than 524,000 people, representing 4.6% of the Ontario population. There has been a net decline in the population since 1996. The population has lost 25,000 citizens between 1996 and 2001, representing a loss of 5% in 5 years or an approximate rate of 1% a year. Unemployment is higher than average in Ontario with an average unemployment rate of 9.4% compared to 6.1% for the whole province.

Table 1: Demographics in Northern Ontario

2001 Canadian Census Data	Timmins	Greater Sudbury	Thunder Bay	Sault Ste. Marie	North Bay	Kenora Region	Ontario
Total Population 2001	43,686	155,219	120,370	78,908	63,681	61,802	11,410,046
1996 to 2001 population change (%)	-8.0	-6.1	-3.7	-5.6	-1.7	-2.5	6.1
Population density per km ²	14.8	46.3	47.9	110.3	61.8	0.2	12.6
Immigrated between 1991 and 2001	195	1,035	1,325	335	275	455	1,022,370
Employment rate (%)	56.7	56.3	58.2	53.9	57.1	58.5	63.2
Unemployment rate (%)	11.2	9.1	8.8	9.5	8.4	11.1	6.1
Numbers of people working in health and education	3,870	14,585	13,030	7,375	6,590	5,875	902,990
Natural and applied sciences and related occupations	1,260	3,500	3,005	2,005	1,635	1,345	422,510
Population aged 20-34 with a university certificate, diploma or degree (%)	11.4	16.60	19.20	17.10	16.80	9.90	25.7
Population aged 35-44 with a university certificate, diploma or degree (%)	10.8	13.90	17.40	16.10	17.40	12.20	24.3
Population aged 45-64 with a university certificate, diploma or degree (%)	11.6	14.30	18.20	16.00	18.20	12.90	21.5

Industry

The job market of Northern Ontario sustains more than 300,000 jobs in several sectors. Health care/social assistance is the second largest employment sector in Northern Ontario (13%). Only

retail is larger (14%). Manufacturing is the third most important sector for the region in terms of employment providing jobs to 35,000 people. Importantly, professional scientists and technicians represent a little more than 3% of the job market.

While mining and oil/gas extraction employs only 10,755 people i.e. 3% of the job market, it is 10 times the average ratio for Ontario, highlighting the critical role that the region serves in these two sectors. Other sectors that benefit from a greater ratio of job opportunities in comparison to Ontario as a whole are healthcare/social assistance, accommodation/food services, and education. Neglected sectors are company management, financial services/insurance, and professional scientists and technicians; the latter being of particular importance to this endeavor.

Table 2: Jobs in Northern Ontario

Sectors	Jobs in Northern Ontario
Retail trade	43,330
Health care and social assistance	39,885
Manufacturing	35,205
Accommodation and food services	26,875
Educational services	25,385
Public administration	24,385
Other services	15,215
Transportation and warehousing	14,645
Construction	10,780
Mining and oil/gas extraction	10,755
Waste management and remediation	10,260
Professional scientific and technical services	10,235
Finance and insurance	8,355
Agriculture forestry fishing and hunting	7,855
Wholesale trade	7,855
Arts entertainment and recreation	5,545
Information and cultural industries	5,340
Real estate and rental and leasing	4,270
Utilities	2,890
Management of companies and enterprises	140
All industries	309,210

MEDT based on Statistics Canada 2001 Census data

Up to 22,000 peoples work in hospitals, outpatient centres, and home care services. These organizations constitute one of the key employers along with the natural resource industries.

The average wages in the health and health related sectors vary from city to city (**Table 2**). They vary from \$11.77 for assisting position in health services to \$28.28 for a registered nurse. Health care related jobs wages compares favorably with other key industries of the region, namely retail with that has an average wage of \$12.26, as well as primary industry and manufacturing with both average wages around \$18.

Table 3: wages in health-care related jobs in NO

Health workers	Average wage					
	Thunder Bay	Sudbury	Sault-Ste-Marie	Timmins	North Bay	Toronto
Registered Nurses	\$27.67	\$25.15	\$28.28	\$26.00	\$26.76	\$27.80
Licensed Practical Nurses	\$20.99	\$18.43	\$19.82	\$18.00	\$19.50	\$19.62
Dental Assistants	\$15.79	\$14.47			\$14.15	\$16.06
Nurse Aides, Orderlies and Patient Service Associates	\$16.09	\$14.67	\$13.71	\$14.90	\$14.55	\$14.13
Other Assisting Occupations in Support of Health Services	\$17.04	\$12.76	\$15.34		\$11.77	\$13.79
Biologists and Related Scientists	\$21.33		\$17.98			
Biological Technologists and Technicians	\$19.09		\$18.57			

Compiled from: Human Resources and Skills Development Canada: www.labourmarketinformation.ca

Life Sciences Companies

Northern Centre for Biotechnology and Clinical Research (NEUREKA!)

<http://www.neureka.com/>

A non profit organization aimed at providing both clinical research and biotechnology products and services to life science companies ranging from academic institutions to biotechnology companies.

Genesis Genomics

<http://www.genesisgenomics.com/>

Genesis Genomics is a Thunderbay biotechnology company that specializes in mitochondrial DNA research in the oncology field. Some of their recent advances in skin cancer detection will be soon trialed in the United Kingdom.

Molecular World

<http://www.molecularworldinc.com/>

Based in Thunderbay, this company used nuclear and mitochondrial DNA testing for specialized testing that includes forensic and paternity applications.

Wardrop Engineering

<http://www.wardrop.com>

Wardrop is an engineering firm with 7 offices across Canada, including their head office in Thunderbay, and one office in Minneapolis. Wardrop provides bioinformatic services to health care industry.

Medcura

<http://www.medcura.ca/>

This Sault Ste. Marie company is owned and operated by the Group Health Centre, provides management, educational and consulting services to other health facilities.

NorPharm Biotech

Located in Northwestern Ontario, this new company is focused on agricultural research and specifically, medicinally oriented crops.

INFRASTRUCTURE AND INITIATIVES**Educational Institutes****NORTHERN ONTARIO SCHOOL OF MEDICINE**

<http://www.normed.ca>

The inaugural class made up of 56 students (32 in Sudbury and 24 in Thunder Bay) commences in September 2005. The School is a joint collaboration of Laurentian University and Lakehead University.

LAURENTIAN UNIVERSITY (GREATER SUDBURY)

<http://www.laurentian.ca>

7758 full time and part time students

500 Masters students

15 Ph.D. students

327 Full time faculty members

ALGOMA UNIVERSITY COLLEGE (SAULT STE. MARIE)

<http://www.auc.ca>

1,200 part time and full time students

LAKEHEAD UNIVERSITY (THUNDER BAY)

<http://www.lakeheadu.ca/>

6,200 full-time and part-time students

1,600 faculty and staff

Offers science, biology and biochemistry undergraduate and masters programs; health programs include kinesiology, medical and lab studies, nursing and social work; applied biomolecular program and a masters in public health. The university is considering offering a doctorate in life sciences.

NIPISSING UNIVERSITY (NORTH BAY)

<http://www.nipissingu.ca/>

SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

<http://www.saultc.on.ca/>

2,135 students in 2003

CONFEDERATION COLLEGE

<http://www.confederationc.on.ca/>

3,200 full-time students.

Programs include dental assistant, practical nursing, and medical radiation technicians.

Medical Facilities

There are over 40 hospitals in Northern Ontario with a total of 3563 public beds staffed in 2003. Smaller facilities are generally affiliated with a larger area hospital such as Sudbury, Thunder Bay or Sault Area Hospitals. The breakdown of these beds is shown in the table below.

Beds	total
Acute	1986
Mental Health	585
Chronic	889
General Rehabilitation	58
Special Rehabilitation	45
Total	3563

Sault Area Hospital is currently on two sites in the downtown area. A new 300 bed hospital has been announced in Sault Ste. Marie to serve the Algoma area. The target completion date is 2008. The Algoma Regional Cancer Centre will likely be located in the new hospital.

Thunder Bay Regional Health Sciences Centre (TBRHSC)

TBRHSC opened its new facility in February 2004. It is a state of the art acute care facility and teaching hospital on 70 acres of land which works with other regional hospitals to serve the health care needs of Northwestern Ontario residents. TBRHSC is a 375 bed tertiary care facility with a fully integrated regional cancer center. This centre has state of the art equipment ranging from ultrasounds, MRI, CT Scanners and Simulators, Stereotactic Biopsy Units, Laser vision care systems etc.

Northwestern Ontario Regional Cancer Centre

Part of TBRHSC, the cancer centre's new laboratory facility is approximately 70,000 sq ft, of which 12,000 is used for research. This facility has two Siemens ONCOR linear accelerators for radiation treatment (first in Canada). This centre has secured more than \$4 million in cancer research funding in 5 years and has 3 full time career scientists. This centre is also working with TBRHSC, Centre for Global eHealth Innovation (joint effort with University of Health Network and University of Toronto) to increase communications between cancer care providers and patients through telephones and web-based technologies.

Sudbury Regional Hospital is currently undergoing an expansion from three sites to a single integrated facility. The new teaching hospital will serve over 600,000 residents in Northeastern Ontario and will have a complement of over 3,000 staff.

Northeastern Ontario Regional Cancer Centre has now completed its expansion and has total space of 120,000 sq ft., (from its original building size of 66,000 sq ft.) Both the clinical and research infrastructure has increased as a result of this expansion. Laboratory research space has doubled to 12,000 sq ft along with additional office space for the researchers.

North Bay General Hospital is partnering with Northeast Mental Health Centre to create two side by side autonomous facilities referred to as the North Bay Regional Health Centre. It is anticipated that this project will be complete in 2008 or 2009.

Timmins and District Hospital has 167 beds and offers medical, surgical, critical care, maternity, mental health, long term and paediatric services.

Research Centres and Laboratory Facilities

Below is a list of the research facilities available within Northern Ontario. Although not comprehensive, these centres mentioned below are discussed in detail further on in this document.

- Centre for Rural and Northern Health Research (CRaNHR) (Laurentian and Lakehead University)
- Centre of Excellence for Children and Adolescents with Special Needs (Lakehead University)
- Lakehead University Centre for Healthcare Ethics (Lakehead University)
- Northern Educational Centre for Aging and Health (Lakehead University)
- Northwestern Ontario Regional Cancer Centre
- PaleoDNA Laboratory (Lakehead University).
- Group Health Centre
 - *Clinical research office* which gathers data for population based clinical trials and medical research.
 - *Health IT building* will provide opportunities in electronic medical data services, transcription services, and GIS healthcare initiatives.
- Algoma Regional Cancer Centre – limited cancer research is being conducted here through Cancer Care Ontario.
- Great Lakes Forestry Centre and Ontario Forest Research Institute – offer some crossover work with health research.

New and Ongoing Initiatives

Below is a list of health initiatives within Northern Ontario. This is not a complete list but is intended to highlight the current projects within the North.

- Thunder Bay Regional Health Sciences Centre has applied and the review process for Canadian Council on Hospital accreditation.
- Northern Ontario School of Medicine buildings in both Thunder Bay and Sudbury will have approximately 20,000 sq ft research facilities. FedNor has announced funding of \$6 million to be applied towards the development of the laboratories, equipment, and technology to ensure that long distance communication is available to the students.
- The Northwest Health Network (NW Net) is expanding its storage network all of the NORTH Network sites (13 regional hospitals) in order for practitioners in over 30 medical specialties to have immediate access to patient records and data across Northern communities. The NORTH Network connects over 70 sites throughout Northern and Southern Ontario, and Winnipeg Health Sciences Centre in Manitoba.
- In the fall of 2004, Thunder Bay Regional Health Sciences Centre, Lakehead University, and the Northern Ontario School of Medicine formally created a partnership and formed ICR Discoveries Inc. **ICR Discoveries Inc.** will “undertake, develop, and support cancer research and related programs in Northwestern Ontario that will improve the prevention, screening, supportive care, palliative care, diagnosis, and treatment of cancer. This includes a focus on cancer issues of the people of Northwestern Ontario.” (Mission Statement - www.tbrhsc.net)
- Northern Centre of Excellence for e-Health, health evidence and physician development is currently being proposed by a group of local doctors in Thunder Bay. This partnership

- among local doctors, the private and public sector would focus to better the areas of clinical, research, e-health, physician development and health evidence.
- Lake Superior Centre for Regenerative Medicine Inc., a tissue bank and regenerative medicine research facility is in the process of obtaining funding to develop the first phase of its program, the establishment of the tissue bank. A business plan has been completed for all phases including the future development of a regenerative medicine research facility.
 - Lakehead University is currently completing their research strategic plan for 2005 to 2011.
 - Proposed new Lakehead University Lifesciences center for private sector, healthcare and academic research. This building will be approximately 150,000 sq ft and is funded in part by the Biotechnology Cluster Innovation Program and other public sources. This is in partnership with NOSM.
 - Group Health Centre is currently completing an information technology (IT) feasibility and technical study to assess the costs and partnering opportunities associated with the development of multimedia communications and integrated solutions related to the delivery of health services.
 - Geraldton Community Forest Inc. is currently conducting a feasibility study and completing a business plan to determine the economic benefits of an operation that would grow and harvest Canada yew. Canada yew or ground hemlock contains an ingredient which is used in cancer treatment drugs. (Greenstone region)
 - Proposed Physician Incubator (Thunder Bay)
 - Proposed Material Bioscience Centre lead by Dr. Heidi Schraft at Lakehead University
 - Proposed shared services platform for sciences and health that is similar to the Markham model is currently being considered (Sault Ste. Marie).
 - Northern Ontario Biotechnology Initiative (NOBI), the Regional Innovation Network is moving forward. The Northern Ontario communities are starting to work together with other Regional Innovation Networks. In terms of NOBI, an Executive Director and the three sector specialists will be hired in the summer 2005 and will begin to move the biotechnology sector forward in Northern Ontario. The three sector specialists will be located in one of Thunder Bay, Sault Ste. Marie or Sudbury, while it is believed that the Executive Director will be located in Toronto near MARS.
 - A regional life sciences marketing plan in partnership with the City of Thunder Bay and local community stakeholders has been developed and funding to carry out the marketing plan is currently being sought.
 - Laurentian University is creating a Chair in Cancer Research Initiative.
 - Laurentian University is proposing a PhD program in biomolecular science.

IDENTIFYING OPPORTUNITIES WITHIN THE HEALTH RESEARCH INDUSTRY

BASIC SCIENCES

Basic science is at the root of medical progress; it is about identifying the cause of diseases and engineering molecules to overcome pathology. More recently with the advance of genetic engineering we can, for the first time, address diseases at the gene level. Basic research is also about developing devices for diagnostic or treatment purposes. It also involves understanding the epidemiology of disease from population studies. Basic science is costly and time consuming, it can take decades to unravel the fundamental molecular events that lead to pathologies; therefore, most basic research is conducted with public funds. However, discoveries from basic research are at the forefront of commercial ventures in the human health industry.

Relevance to Northern Ontario

During recent decades, biomedical research has achieved great milestones. The discovery of the DNA structure has led to molecular biology, the sequencing of the genome, gene engineering, genomics, and soon gene therapy. Advances in immunology have led to monoclonal antibodies, therapeutic antibodies, molecular vaccines, and more. Advances in molecular structure, with NMR and X-ray crystallography, are now permitting rational drug design. These are just a few examples of how biomedical research is transforming the way we do research and how we approach medicine. All these tools and advanced knowledge are leading to new paradigms in medical practice, namely the rise of personalized medicine and better knowledge on preventive medicine.

This progress is driving the health industry to become a major driver of economic growth in the coming years. It is imperative for the Northern Ontario region to seize this opportunity to bolster its economy. The region has already several assets to venture in the health industry (see below). Notably, it is building a medical school, has several existing health research activities, and already nurtures highly qualified personnel (HQP). Northern Ontario's unique context in terms of scientific assets, socio-demographic profile, and political environment could be leveraged to tap into this growing industry that will transform tomorrow's economy. By aligning its assets with the great opportunities that exist in this booming industry, Northern Ontario will allow the region to become a significant centre for the health industry and foster local economic development.

Existing Capacities

In Canada, basic research in the health sector mainly occurs in academic laboratories. Universities and hospitals are host to most Canadian biomedical research; and several institutions in Northern Ontario are part of this effort. Below is a list of organizations in Northern Ontario that are conducting basic research.

Laurentian University (Sudbury)

The **Laurentian University** faculty comprise researchers involved in biomedical research, including human kinetics, chemistry of apoptosis, and cancer. The University holds Canada Research Chairs and Ontario Research and Development Challenge Fund Chairs, including:

- The Chair in Biomolecular modeling, molecular structures and dynamics (Arteca, Gustavo, Dept. of Chemistry and Biochemistry)
- The Chair in Molecular biology, microbiology, septic shock (Kumar, Aseem, Dept. of Chemistry and Biochemistry)
- The Chair in Cancer Research (Parissenti, Amadeo, Northeastern Ontario Regional Cancer Centre, Dept. of Chemistry and Biochemistry)

The public research funding obtained by Laurentian University's researchers in relation to life science has significantly increased in recent years. For 2005-2006, researchers from the Laurentian University will receive cumulative funding of \$721,539 from the CIHR¹.

Basic research is being conducted at the **Northeastern Ontario Regional Cancer Centre (NEORCC) in Sudbury**. The NEORCC is actively involved in experimental cancer research. It performs research in peripheral stem cells, immunology, molecular biology, epidemiology, psychosocial and behavioral research; radiation, physics and dosimetry research. The centre's basic research is performed by the **Tumor Biology Research Group**. The group's four tumor biology researchers have garnered significant national peer recognition, and have been awarded a number of research grants from Canada's peer-reviewed research agencies. The NEORCC receives yearly, more than \$750,000 of industrial contracts and collaborations with partners such as Aventis Pharmaceutical (now Sanofi-Aventis), INCO, and Falconbridge. The Tumor Biology Research Group is currently building intellectual property based on its discoveries; namely an agent that kills tumor cells in patients with refractory breast cancer. The group has also developed a panel of isogenic, drug-resistant breast tumor cells lines, which is of great value to researchers and private companies.

The NEORCC hosts two Canada Research Chairs:

1. The Chair in Cancer Research, held by Dr. Amadeo Parissenti for studying Protein Kinase C and Multi-drug Resistance.
2. The Chair in Biomolecular Science, held by Dr. Aseem Kumar for research on sepsis.

Northern Centre for Biotechnology and Clinical Research (NEUREKA!) (Sudbury)

Neureka! Biotechnology Division is partnering with universities, research institutes, and industry to support the translation of basic medical discoveries into products and services. The division conducts research and develops products in diagnostics, biopharmaceuticals and environmental biotechnologies.

Lakehead University (Thunder Bay)

Lakehead University professors are also conducting health research. They have cumulatively received more than \$1 million in funding from the CIHR. Their research activities include among others:

- The psychological and health consequences of care giving: a critical comparison of husbands and wives.
- Identification of genetic, phenotypic, and psychological predictors of hormonal contraceptive side effects: a focus on mood effects.

¹ <http://webapps.cihr-irsc.gc.ca/pls/cris/>

- Structural regulation of histone H1 binding to chromatin in living cells.
- Caregiver burden: decline in the physical health of caregivers of individuals with alzheimer's disease as a function of changes in lifestyle health behaviours.
- Molecular mechanisms for the H2S-induced modulation of K-ATP channels.

Furthermore, the University holds 7 Canada Research Chairs, two of which are related to health:

- Michael Bedard, Dept. of Psychology for Aging and Health
- Heidi Schraft, Dept. of Biology for Molecular Food Microbiology

PaleoDNA Laboratory (Lakehead University)

PaleoDNA Laboratory has recently expanded into an additional laboratory facility at the Northwestern Ontario Technology Centre. This new laboratory is a DNA computer chip-sequencing facility for mitochondrial and nuclear DNA analysis. It will allow researchers and private sector companies, such as Genesis Genomics, to perform high volume DNA sequencing.

ICR Discoveries Institute of Cancer Research, formerly Northwestern Ontario Cancer Research Institute (NWOCRI)

In partnership with the Thunder Bay Regional Health Sciences Centre, the Lakehead University is proposing to develop a cancer research institute. This institute will conduct basic research and aim to support the translation of basic research into clinical research and practice. It will seek to foster multi-disciplinary research activities, and the translation of research through enabling good communication between basic scientists and clinicians.

Regenerative Medicine Research Institute and Tissue Bank Initiative (Thunder Bay)

The Regenerative Medicine Research Institute is a proposed not-for-profit organization that will procure and store cadaveric tissue for biomedical research. It will also conduct research in therapeutic applications of cord blood stem cells for tissue regeneration. The research arm of the organization will generate knowledge in the expanding field of regenerative medicine, with the goal of developing novel cellular therapies for damaged tissue repair.

Genesis Genomics (Thunder Bay)

Genesis Genomics is a privately held biotechnology company that is building a database of mitochondrial DNA mutations for cancer staging and early detection. Scientists at Genesis Genomics through their renowned mitochondrial DNA research and their international collaborations, have established Thunder Bay as a centre for mitochondrial research. Genesis genomics nurtures the vision of establishing a world class research facility in mitochondrial medicine within 5 to 10 years; it has built a strong network of partnership with Cormac industries, Wardrop, Lakehead University, Molecular World, the Paleo-DNA laboratory, and the regenerative medicine research institute and tissue bank among others. Genesis Genomics is currently at the process of developing a diagnostic kit for the early detection of prostate cancer.

Nipissing University

The Nipissing University is host to researchers in biology, chemistry and geography. It is seeking the opportunity to build DNA microarray capabilities for the region. There is a growing commitment of Nipissing University to expand its research capacity. The university is investigating opportunities for collaborations in genomics and bioinformatics with the new North

Bay Regional Health Centre (under construction), and the Northern Ontario School of Medicine (NOMS).

Overall Trends

The health industry is one of the fastest growing industries worldwide; and Ontario is a major player in this industry. The number of biotech companies in Canada almost doubled since 1997 with 496 firms generating close to \$4 billion in 2003. Human health is by far the dominant sub-sector of the biotechnology industry with more than half the firms (262), half of the revenue (\$2 billion), and 75% of the human resources². The industry is still nascent and the overall human health sub-sector R&D expenditure represents 65% of its revenues. In 2001 the global market for the health industry was estimated to \$494 billion, 68% of which was taken by pharmaceuticals and 26% by medical devices (**Table 4**). It is estimated that the market for emerging health related technologies will grow from \$173.5 billion to \$6,000 billion by 2030 with nanotechnology being the fastest growing family of technologies (**Table 5**).

Table 4: Global market estimates for the health the industry³

<i>Established Sectors and Subsectors</i>	<i>2001 Global Market (\$US)</i>
Enabling Technologies (Genomics, Proteomics, Pharmacogenomics, Bioinformatics)	\$7.6 B
E-health	\$16 B
Pharmaceutical	\$337.2 B
Medical Devices	\$130 B
Total	\$494.3 B

Table 5: Global market size for the emerging life sciences sectors⁴

<i>Emerging Life Sciences Sectors</i>	<i>2005 Global Market Size (\$US)</i>	<i>Estimated Annual Growth Rate</i>
Biosensors	\$5.4 B	35%
Biomaterials	\$80.5 B	30%
Stem Cell Technologies	\$66.4 B	35%
Biophotonics	\$8.0 B	45%
Microfluidics (Biochips)	\$1.7 B	20%
Nanobiotechnology	\$500 M	60-75%
Medical Robotics	\$11.0 B	70%
TOTAL	\$173.5 B	

² <http://www.statcan.ca/english/freepub/88-003-XIE/88-003-XIE2005001.pdf>

³ SHI Consulting, 2001 internal data

⁴ SHI Consulting, 2001 internal data

The pharmaceutical industry is facing challenging times: while many marketed drugs are coming off patent, the pharmaceutical firms have some difficulty in filling their drug pipeline with new drug candidate. Despite the advances in high-throughput screening, the number of drug leads has been decreasing. This has led the pharmaceutical industry to seek collaborations and partnerships with emerging and established biotechnology firms to have access to additional innovative drug candidates and technologies. The Biotechnology revolution has not only changed the paradigm of biomedical research but it is entering an era in which the old paradigms of drug discovery are not effective anymore at creating new drugs for current medical challenges. The new paradigms in drug discovery involve rational drug design; the –omics (genomics, proteomics, and metabolomics); cell based assay for drug screening; biotherapeutics including monoclonal antibodies, gene therapies, and cell-based therapies; and the use of biomarkers to predict toxicity, efficacy, and for personalized medicine.

Enabling Technologies

Research centres throughout the region already have significant capabilities that empower them to tackle current challenges and participate to the paradigm shift in drug discovery. The region's core expertise in mitochondrial DNA mutation database, its tissues banks, the commitment of Nippissing University to build a DNA microarray facility, and its core facilities in oncology represent a solid basis to build upon.

Potential Impacts

By further developing its basic research capabilities, the Northern Ontario region will make itself more attractive for local students who aspire to carry a career in health science to pursue it in the region. This will in return create a more dynamic environment for all actors in the health care sectors as well as for entrepreneur to develop ideas and to pursue commercial ventures. As the research culture grows and its scientists established themselves in their unique niche, the region's profile will be raised, attracting national and international students and post-doctoral fellows interested in promoting their careers in these disciplines, further stimulating the dynamism of health research in local organizations.

DISEASE PREVENTION AND THERAPY

Disease prevention and therapies are the outcomes of basic research. While the findings of basic scientists lead the way to innovative solutions, the path that brings a discovery to the service of the population is long and challenging path. From the therapeutic standpoint, once a disease target is identified and a lead molecule synthesized, it needs to be engineered for high specificity, low systemic toxicity, appropriate pharmacokinetics and pharmacodynamics, and shelf stability among others. It further needs to be tested in clinical studies to ascertain that it is safe and efficacious. For disease prevention, hypothesis and findings need to be rigorously validated in robust studies; they need to be translated in practical clinical practices, public policies, and communication campaigns.

Relevance to Northern Ontario

The health profile of the Northern Ontario population is significantly different from the rest of Ontario. Statistics reveal that the Northern population is more susceptible to several conditions⁵:

- The overall mortality rate is 17% higher than average in Ontario
- Cardiovascular disease related mortality, 15%
- Cancer mortality, 11%
- Respiratory disease related mortality, 21%
- Injuries mortality, 32%

The overall mortality rate in Northern Ontario is 17% higher than the Ontario average. These susceptibilities are very likely linked to environmental risk factors and behavioural factors such as high blood pressure, obesity, smoking, and life-style, including occupation. Most of these outcomes can be managed with preventive practices and drug therapy. It emphasizes the critical value for the region to invest in programs that further advance preventive medicine through clinical studies and outcomes studies. Further efforts need also to be directed toward an effective translation of research findings into clinical practice and population policies.

In respect of drug therapy development, the Northern Ontario region hosts several research organizations involved in clinical trials (see below). The region benefits from a unique demography and from very effective clinical teams, such as the clinical trial team of the Northwestern Ontario Regional Cancer Care. These are important assets to leverage into making the region an important hub for key clinical trials; this will further attract good clinicians/researchers, bring prestige to the medical school, and further attract research funding and contracts. While the region can tap on the excellence, flexibility, rapidity, and disease profile of the patient population; its growth will be limited by the size of the pool of patients it serves.

Existing Capacities

Northern Ontario School of Medicine (NOSM)

The Northern Ontario School of Medicine is based on two campuses; the west campus in Thunder Bay and the east campus in Sudbury. Its first classes will commence in September 2005, and will be training 56 students. Its mission is to train future physicians that are likely thrive in the rural northern environment and wish to work and stay in the Northern Ontario region. Its programs

⁵ www.nhip.org: Short report #2, February 2004

will be tailored to the needs of the unique demographics of the region. The medical school will act as a catalyst to further develop current health research activities taking place in the regional universities and centres. Its faculty members will conduct a wide spectrum of research: biomedical, clinical, public health, population health, epidemiological, psychological and social sciences and health services research. The medical school will contribute to building research capacity that will be tailored to the specific needs of the northern rural community. In addition, the school is seizing this great opportunity to develop clinical and teaching models based upon Tele-Health.

Lakehead University centre for health care ethics CHCE

The CHCE research aims to improve the ethical standards of the health care stakeholders in the community and to develop and promote best practices. It provides forums for interdisciplinary dialogue between Lakehead University faculty, students, members of the health care professions, researchers, administrators and the public. The centre organizes a colloquium series, workshops and conferences. CHCE's initiatives focus on issues such as:

- End of life decisions
- Ethics of research with human subjects
- Aboriginal health ethics
- Religious and cultural interpretation
- Allocation of scarce resources and professional codes of ethics.

The Centre for Rural and Northern Health Research (CRaNHR)

The CRaNHR is a multidisciplinary centre that regroups investigators from disciplines such as: administration, economics, epidemiology, geography, gerontology, kinesiology, medicine, nursing, social work and sociology to conduct studies relating to the specific challenges of rural health. Rural health is a complex matter due to the interaction of many socioeconomic forces and diverse policies.

Centre for Education and Research on Aging and Health (CERAH)

CERAH is active in research on palliative care, psychogeriatric training, caregiver assistance, successful aging, falls prevention, depression, elder abuse, and health informatics. It collaborates with the departments of education, kinesiology, psychology, social work and sociology. The CERAH also has an educational mandate; it sponsors conferences, workshops, and training in gerontology.

Resource Centre for Occupational Health and Safety

The resource centre is actively involved in promoting best practices in industrial hygiene services. It provides university courses for the engineering and nursing programs. It also offers professional development courses and specialized training. Its library holds more than 9000 books, journals, papers and periodicals that are made readily accessible to students as well as the general public. The resource centre also offers laboratory analyses.

Northwestern Ontario Regional Cancer Centre (NORCC): to become ICR Discovery

The cancer centre has a comprehensive cancer care program that thrives to provide the highest standard of care. It collaborates with regional partners in promoting prevention, early detection as well as providing diagnosis, treatment, and supportive care. The centre also has outstanding research, education, and training programs. Through a partnership with Siemens, the centre has state-of-the art ONCOR linear accelerator; and will further host Siemens new equipment development and training programs.

Northeastern Ontario Regional Cancer Centre (NEORCC)

Along with its healthcare provision mandate, NEORCC is actively involved in research. It conducts clinical trials in radiotherapy and chemotherapy; it performs research in stem cell, immunology, molecular biology, epidemiology, radiation physics, and others. The main research activities are regrouped in four themes:

- Tumour Biology Research Group: This group focuses on molecular and cellular biology for "translation" of basic research into clinical practice.
- Epidemiology Research Unit: This unit conducts studies for determining and comparing cancer incidence, mortality rates, and risk factors for various cancers in Northeastern Ontario. It further specializes in the role of occupational activities into health outcomes as well as into cancer screening, program evaluation, and cancer survival.
- Clinical Research: This team conducts clinical trials from phase I to III in the areas of breast, lung, prostate, colorectal, gastric, head and neck cancers as well as acute and chronic leukemias, melanoma and sarcoma. The clinical research team collaborates with national and provincial organizations such as: the National Cancer Institute of Canada Clinical Trials Group (NCIC CTG), the Radiation Therapy Oncology Group (RTOG), and the Ontario Clinical Oncology Group (OCOG). Moreover, many clinical trials are sponsored by pharmaceutical companies.
- Department of Medical Physics: This department researches are devoted to:
 - The production of undistorted digital simulator images
 - The reliability of subjective evaluation of on-line electronic portal images
 - The generation of CT images at megavoltage energies
 - The automatic registration of prescription and treatment images to verify patient position.

A recent increase in the number of researchers at NEORCC can be attributed to the increased available lab space. Dr. Parissenti is spearheading a biomolecular PhD program at Laurentian University. He has also established a molecular diagnostics service associated with the hospital. Dr. Parissenti has also partnered with Innovation Foundation with University of Toronto to sell drug resistant cell lines that were developed in his laboratory.

Northern Centre for Biotechnology and Clinical Research (NEUREKA!)

NEUREKA! is a not-for-profit organization that provides innovative products and services in the areas of life sciences. This organization currently has 30,000 sq ft of laboratory space for animal housing as well as wet and dry lab space. One of its two divisions offers clinical research in partnership with pharmaceutical companies that encompass several medical specialties such as: internal medicine, cardiology, respiratory, gastroenterology, orthopaedics, oncology, gynecology, infectious disease and psychiatry. Its large network of clinical investigators allows Neureka! to provide multifunctional services for pharmaceutical companies and research institutes. Its

strengths are its rapid and accurate execution. It offers clinical research associates, clinical study coordinators, assistance for investigators in the recruitment of patients, and project management. Using a network of over 100 physicians, NEUREKA is able to undertake preclinical and Phase I to Phase IV clinical trials. NEUREKA is developing a cholesterol marker kit and a viral diagnostic kit with various partners. West Nile virus research is underway.

The Northern Diabetes Health Network

The Northern Diabetes Health Network is working to improve diabetes prevention and management in the community. To this end, it offers access to several programs through the Network of Northern Ontario Diabetes and the Network of Ontario Pediatric Diabetes. The Northern network assists children, young adults, and adults in accessing the services of each program. Moreover the Northern network, offers professional development opportunities to local healthcare professionals and providers.

Group Health Centre (GHC) (Sault Ste. Marie)

The GHC is conducting clinical trials that include outcomes evaluation and chronic disease management. It benefits from a comprehensive Electronic Medical Record (EMR) that allows better data management and makes it possible to conduct comprehensive retrospective and prospective studies. It has programs in diabetes, congestive heart failure-discharge transition, anticoagulation clinic, mammography, and immunization, while-smoking-cessation, vascular intervention, falls and fractures/osteoporosis, and cervical screening programs. The GHC has a primary care registry that is the largest in Canada. The centre has collaborated with McMaster University on the COMPETE trials (Computerization of Medical Practices for Enhancement of Therapeutic Effectiveness). Moreover, it has also collaborated on a Tele-Health study.

Northgate Medical Clinic (North Bay)

The Northgate Medical Clinic serves approximately 10,000 patients with primary care as well as follow-up care in Cardiorespiratory, Endocrine, Gastroenterology, Rheumatology and Respiratory. Its medical research team regularly participates in Phase III and several Phase IV Trials.

ProBity Medical Research (North Bay)

ProBity Medical Research conducts clinical trials in dermatology including studies with new developmental drugs and biologicals.

North Bay Research (North Bay)

North Bay Research is involved with clinical trials (Phase II and Phase III) and medical device trials.

Overall Trends in Disease Prevention and Therapy

In recent decades, health has become a central concern for most developed countries. Two key forces are driving health care costs up; the availability of new innovative drugs and tools that allow us to better treat ailments for which they were only limited options in the past. These new

tools are generally more expensive and require upfront investments that provide only indirect long-term social benefits. Secondly, the aging of the population is becoming an important driver of the healthcare costs as this sub-population represents the biggest consumer of health care services. Additionally, the obesity epidemic that is occurring in North America, will likely translate into an important rise in health care provision for cardiovascular diseases and diabetes in the near future.

Nonetheless, it is comforting to know that our wealth of knowledge around cardiovascular diseases and diabetes is empowering us to adopt preventive behaviour toward avoiding or delaying these debilitating ailments. This is articulated with the rise in preventive medicine and communication program to inform people of healthy options and the importance to manage chronic condition such as high cholesterol levels, blood pressure, or diabetes.

In Canada the burden of disease was estimated to amount to \$159 billion for 1998. Of this amount, \$84 billion was dedicated to direct cost i.e. hospital care, physicians, drugs, etc. But it is also important to take account of the social cost of premature mortality and morbidity, which was valued at \$75 billion in 1998. Hospital expenditures were estimated to represent 33% of the direct costs and prescription and non-prescription drugs, 15%⁶.

The three main disease area impacting on economic burden of healthcare were cardiovascular diseases, musculoskeletal diseases, and cancer. However, those that are the most costly to treat are cardiovascular diseases, mental disorders, and digestive diseases. This highlights the impact of diseases with high morbidity on the overall cost of healthcare, namely, musculoskeletal diseases and cancer. It is noteworthy that injuries are an important component of healthcare costs both in direct and indirect costs (**Table 6**).

Table 6: Economic burden of top 5 diseases

Direct cost (millions)		Total cost (millions)	
Cardiovascular diseases	\$6,818	Cardiovascular diseases	\$18,473
Mental disorders	\$4,681	Musculoskeletal diseases	\$16,381
Digestive diseases	\$3,540	Cancer	\$14,220
Respiratory illness	\$3,461	Injuries	\$12,737
Injuries	\$3,225	Respiratory illness	\$8,531

EBIC 1998, Health Canada

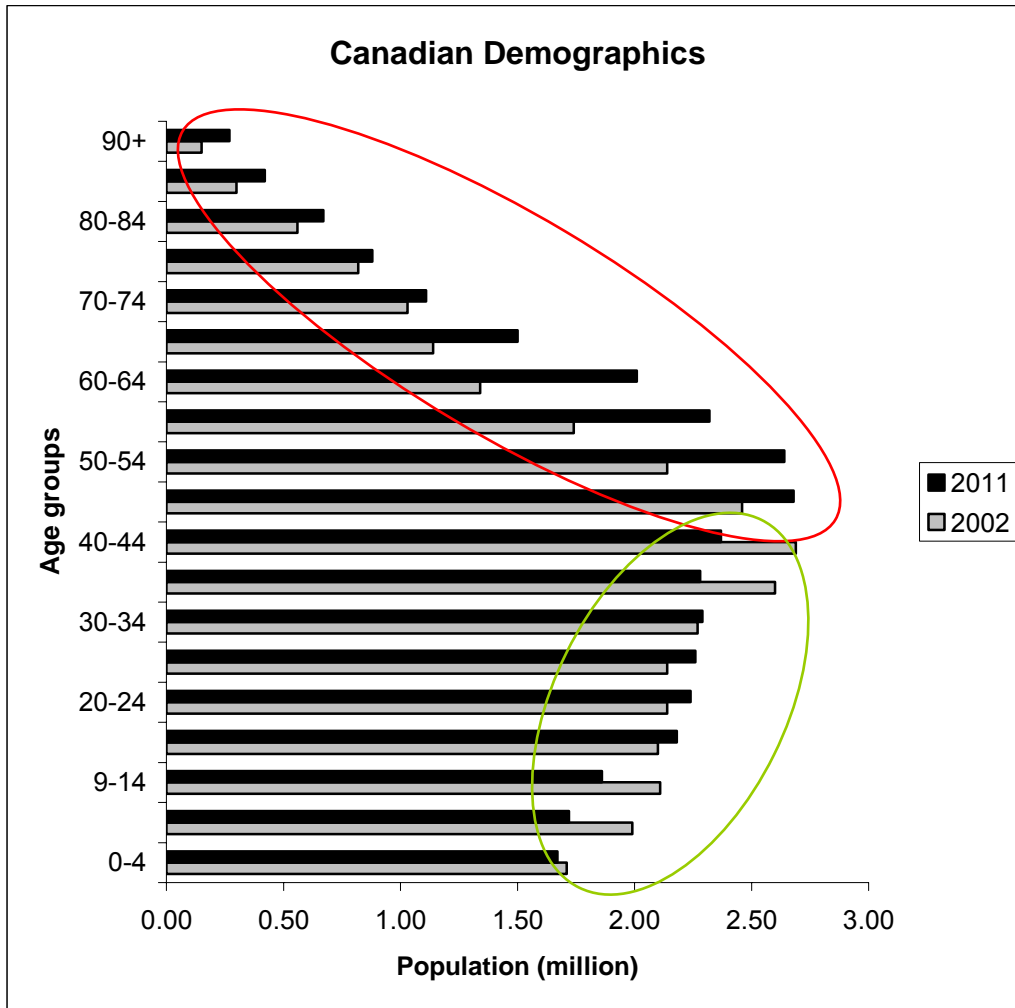
Aging

The aging of the population is a major component of the burden of disease. Seniors (>65 years old), in 1998 accounted for 30% of the burden of diseases, while they represented only 12,7% of the population. As demographics evolve toward an aging population, the proportion aged over 65 year will rise to 14,5% in 2011⁷, the economic impact of diseases will be doubly impacted by higher cost of healthcare and a smaller economically active population.

⁶ EBIC 1998, Health Canada

⁷ Statistics Canada, <http://www.statcan.ca/english/Pgdb/demo23b.htm>

Table 7: Canadian demographics



Cancer

The number of new cancer cases is rising and will continue to rise in Canada, as well as in many other developed countries. In fact, the increase in cancer death is much greater than for other diseases. Cancer is likely to pass cardiovascular disease as the first cause of death. In 2004, it was estimated that 145,500 new cancer cases would have been diagnosed. It is predicted that over the next 30 years, close to 5.8 million Canadians will be diagnosed with cancer, of which 2.7 million are expected to die from it⁸. The increasing incidence of cancer is an important economic burden for Canadians. Not only the direct healthcare costs are rising but also cancer morbidity is causing important losses in taxation revenues. It is estimated that Canada will lose over \$250 billion in taxation revenues over the next 30 years due to disability and mortality related to cancer. These increases are due to both the increase in healthcare management cost inflation and to the aging of the population. As the population grows older, the incidence of cancer grows too since the risk of developing cancer increases with age.

⁸ Data from Risk Analytica

Obesity

Obesity is another trend that will severely impact public health and the burden of diseases. While the obesity epidemic is primarily observed in the United States, the problem is also present in Canada and particularly in Northern Ontario where obesity is higher than in the rest of the province. It is anticipated that obesity will cause as much death as cigarette smoking. In the United States 1 adult out of 4 is obese. Obesity increases the risk of mortality by 50% to 100%. In Northern Ontario, overweight and obese people represent 37% of the population. Obesity will severely contribute to healthcare challenges in the coming decades.

Enabling Technologies

The Northern Ontario region has well established clinical teams in several therapeutic areas. Teams both in the public and private sector have established strong links with the pharmaceutical industry. Clinical trials spanning phase II to IV are being conducted in the region. The cancer centre in Thunder Bay is equipped with a state of the art accelerator for radiotherapy and is positioned to host clinical trials of new instruments as well as the training of professionals on these leading edge devices. Furthermore, the region has several groups actively involved in community outreach. The major challenge in preventive medicine is the ability to communicate the information to the general practitioners and to the broader community.

Potential Impacts

The growing importance of the health industry for economic growth represents an excellent opportunity for Northern Ontario to capitalize on its assets to spin off companies in this emerging sector and to attract additional investments in local R&D. By fostering health research and the local growth of this industry, Northern Ontario will further improve health care for its population by providing access to experimental therapies, and to health care professionals that are at the leading edge of their discipline.

HEALTH SERVICES (RURAL AND ABORIGINAL POPULATIONS)

Rural Health Services refers to the research, financing, organizing and delivery of health related services to people and communities residing in locations that are remote or away from large health infrastructure. Activities can include studies of health issues specific to more remote locations, preventive healthcare and health delivery.

Relevance to Northern Ontario

This region comprises 822,000 square kilometres and accounts for nearly 90% of Ontario's total land area but contains only approximately 7% of Ontario's population. Within this Northern population, 18% are francophone and 10% are first nations. The Northern francophone population accounts for 29% of Ontario's total francophone population and, the Northern first nations account for 43% of Ontario's total aboriginals. Northern Ontario's rural population comprises over 1/3 of the total Northern Ontario population⁹.

This vast territory and diffuse and varied populations present different challenges to healthcare delivery than those of larger cities with significant infrastructure (health and non-health related) and personnel. Ensuring that the quality of healthcare delivery meets a community's needs and stays current with new medical advances require many challenges to be overcome. These challenges include:

- attraction and retention of healthcare professionals to rural or remote locations;
- delivery of a consistent standard level of care within a timely manner;
- provision of healthcare that respects and understands a community's culture and values;
- access to specialized medical expertise and technology;
- proper training and education of health professionals providing care in the North.

To overcome these challenges, healthcare professionals must work with English, French and First Nations communities. Furthermore many of these communities do not have the requisite infrastructure to support specialized care that is now associated with today's medical practice and standards of care. Rural services could forge stronger links with larger health centres to enhance disease prevention, management and treatment. This would include developing the infrastructure and training to successfully integrate into a larger health networks.

Existing Capacities

FIRST NATIONS HEALTH

Anishnawbe Mushkiki Aboriginal Health Access Centre

<http://www.anishnawbe-mushkiki.org/>

This Thunder Bay primary care facility provides health promotion and illness prevention programs to the Metis, non-status, status and Inuit within the district of Thunder Bay community. Thirteen health professionals are on staff at this centre. Specifically, the clinical services offered by this

⁹ http://www.mndm.gov.on.ca/mndm/nordev/redb/sector_profiles/northern_ontario_e.pdf

organization include: pre and post natal care; family health care; immunization; sexual health counseling; screening and monitoring of chronic illnesses and referral services to specialists.

Dilico Ojibway Child and Family Services

<http://dilico.com/>

This child and family services center delivers health, mental health, addiction and child welfare services to the Thunder Bay, Armstrong, Longlac, Mobert and Nipigon. The mental health services are provided by specialists in Thunder Bay or for more serious or complex cases treatment can occur through Tele-Psychiatry through Toronto Hospital for Sick Children.

Weeneebayko Health Ahtuskaywin

<http://www.wha.on.ca>

Incorporated in 1993, the Weeneebayko Health Ahtuskaywin aims to create a self-governing healthcare system in the Mushkegowuk region. This region encompasses a population of approximately 10,000 Cree First Nations individuals. Assets and funding include the Weeneebayko General Hospital, and community health services the funding for the Kingston Air Charter, the Geaganano Residence and the Native Patient Services program both also in Kingston plus and the Ministry of Health's funding for Physician Services. The Weeneebayko is a 58-bed acute care teaching hospital with links to Queen's University, the University of Toronto dental faculty, and McMaster University for psychiatry support.

Keewaytinook Okimakanak Telehealth (KO Telehealth)

<http://telehealth.knet.ca/>

KO Telehealth is part of Keewaytinook Okimakanak (Northern Chiefs) network (KNet). KO telehealth is a telemedicine program designed to deliver services to remote Northwestern communities. The goal is to expand the service to 19 participating communities from the 5 current ones. FedNOR, the Northern Ontario Heritage Fund Corporation (NOHFC), Sioux Lookout First Nations Health Authority (SLFNHA), NORTH Network, First nations Inuit Health Branch Ontario Region, Primary Health Transition Fund and Health Canada have all participated in this program. FedNOR has invested over \$2.3M into the K-NET program, Industry Canada donated \$14M in satellite access and Bell Canada invested \$20M to upgrade its Northern Microwave network.

RURAL MEDICINE

Northern Diabetes Health Network (NDHN)

<http://www.ndhn.com/>

This network is comprised of adult and child programs working with English, French and Aboriginal groups. This network has its head office in Thunder Bay and since its inception NDHN has provided service to approximately 53,000 patients out of a total of 57,000 people with diabetes in Northern Ontario. A project is underway to create an electronic diabetes records system to manage this large number of patients. Also, NDHN is working with Northern Ontario Colleges to offer a 2-year diabetes management certificate.

- In the adult program called *Network of Northern Ontario Diabetes Programs (NNODP)*, 39 community-based programs are located across Northern Ontario that aid diabetics self manage their disease. Multidisciplinary teams work with a patient's family physician or specialist. Team members can comprise social workers, chiroprapist,

community support worker as well as healthcare providers. A total of 7,300 adult patients in Northern Ontario accessed the program in 2004.

- Similar to the NNODP, the *Network of Ontario Pediatric Diabetes Programs (NOPDP)* consists of 34 specialized pediatric programs in Northern Ontario that consists of multidisciplinary teams that also include pediatricians and pediatric endocrinologists. Over 92% of children with diabetes accessed this program in 2004.

Northern Medical Clinics

http://www.dimes.on.ca/programs/access_north_med_clinic.asp?sect=access

The March of Dimes, Ontario Government, and Specialists from Toronto and London, who volunteer their time, care for patients that do not have access to certain medical specialties locally. These doctors travel to Cochrane, Hearst, Timmins and Kirland Lake to provide Spine and Rheumatology medical care.

Centre for Rural and Northern Health Research (CRaNHR)

<http://cranhr.laurentian.ca/>

Located at both Laurentian and Lakehead Universities, CRaNHR conducts interdisciplinary research on rural health to improve both access and delivery of healthcare services. Current research projects include evaluating Telehealth/NORTH, assessment of telemedicine and care giving and work practitioner workforce surveys. Completed projects include assessment of resources issues for national initiative for telehealth guidelines¹⁰.

¹⁰ <http://cranhr.laurentian.ca/pdf/Ch6aNIFTEhumanresourcesApril302003.pdf>

TELEMEDICINE AND ROBOTICS

NORTH Network

<http://www.northnetwork.com>

This is a consortium of 100 organizations from both the public and private sectors that comprise over 80 telemedicine sites, including ones in Northeastern and Central Ontario and other locations outside of Ontario, including Winnipeg. Participants include hospitals, education organizations, private industry, provincial and federal governments and First Nations Communities. This system is used for interactive patient consultation and educational activities for multi-specialties. Currently there are four special projects that allow emergency room physicians to access specialized health professionals instantly. These include:



Telemedicine-enabled Communities Partnering with NORTH Network

- *Electrical burn project.* – Launched in September 2003, this project is in collaboration with Sunnybrook and Women’s hospital, HydroOne, Criticall Ontario and the NORTH Network.
- *Telestroke* – started in 2002 through funding from Canadian Stroke Network, Ontario’s Ministry of Health and Long Term Care and NORTH Network. North Bay and Sudbury work with Toronto Western, Toronto General, Sunnybrook and Women’s College hospitals. This system handles emergency consultations along with virtual rounds.
- *Telecorrections* – under development.
- *Teleprimary Care* – As of April 1st 2004, funding was released for this project from the Ministry of Health and Long Term Care funded Primary Health Care Transition Fund Project. This will link nurse practitioners and family physicians using video conferencing and peripherals. This is currently organized in a North East, North West and West cluster.

Criticall Ontario

<https://www.criticall.com>

Servicing more than 140 Hospitals, this is a network that provides instant access to experts across the province. The first phase of an Admit/Discharge/Transfer (ADT) automated system is currently being piloted in 20 hospitals with Thunder Bay Regional Hospital as one of 3 primary hospitals involved with the project¹¹. This project interfaces the Ontario Provincial Bed and Resource Registry with a Hospital ADT system.

A Research Chair in Robotics and Mine Automation.

Laurentian University

Dr. Baiden is a world authority on mining automation and has invented the world's first teleremotely operated mining machines. One of his projects involves developing remotely operated machines for underwater mining using high quality video¹². He currently holds Canada's only research chair on robotics and automation.

Penguin ASI (Automated Systems Inc.)

<http://www.penguinasi.com>

This company's main focus is to design and build robotics for the mining industry. Dr. Baiden, who holds a research chair at Laurentian University, is the Chairman and Chief Technology Officer. Penguin clients include many premier mining companies including Placer Dome and Newmont Gold Company. Penguin has also collaborated with MD Robotics, a MacDonald Dettwiler subsidiary company. MD Robotics has developed, and is maintaining, the robotics for NASA and has now used this knowledge to develop robotics for medical applications. This arm, called the neuroArm, is specifically designed for complex neurosurgery. This application is comprised of two robotic arms that are controlled by the surgeon at a specially designed work station. MR images can be obtained during all phases of an operation without moving the patient. This real time imaging is of great benefit to the patients and surgeons. Currently MD Robotics is collaborating with the Seaman Family MR Research Centre, at the University of Calgary / Foothills Hospital in Calgary.

Networks Centres of Excellence (NCE)**Institute for Robotics and Intelligent Systems (IRIS)**

http://www.precarn.ca/IRIS/index_en.html

Lakehead University has participated in this \$50M research program, a federally funded network that brings together University Researchers across Canada and the United States, from the University of British Columbia to Dalhousie University and including Carnegie Mellon and Rutgers. Projects range from mining and industrial monitoring and controls to medical technologies.

Advanced Laparoscopic Surgery: North Bay

<http://spaceflight.nasa.gov/shuttle/support/training/neemo/neemo7/mckinleybio.html>

Dr. Craig McKinley from North Bay area, Canada's foremost authorities in telerobotic surgery is working with the National Aeronautics and Space Administration (NASA), the Canadian Space Agency (CSA) and McMaster University's Centre for Minimal Access Surgery (CMAS). Dr. McKinley is a world expert in integrating tele-mentored surgery, robotic surgery and tele-robotic

¹¹ Other hospitals include s Norfolk General Hospital and Windsor Regional Hospital.

¹² <http://www.northernontariobusiness.com/regional/Sudbury/headlines.asp?437id145-pn=&view=30437>

surgery in a clinical setting. He is currently associated with NASA Extreme Environment Mission Operations (NEEMO) located off shore in Key Largo, Florida.

Clinidata

<http://www.clinidata.com>

Clinidata is the largest nursing triage service in Canada and one of the five leading nursing triage centers world wide. With over 350 nurses located in Thunder Bay, Sudbury, Toronto, Moncton and Bathurst, Clinicare provides coverage for over 14 million people and handles more than 1.5 million calls per year. Services include:

- *Tele-triage* – enhancement of patient decision making by providing instructions for at home self care, contacting doctors, and 911 or emergency referrals.
- *Public Health Services* – support for patient entry into the healthcare system, inform the public about health issues (eg. West Nile Virus), capture data for reports on emerging health issues.
- *Disease Management* – proactive multidisciplinary approaches.
- *Research* – involved in using technology to complement clinical research and delivery of care.
- *Benefits Management* – information resource.
- *Treatment compliance* – working with patients to ensure proper pharmaceutical usage and limiting adverse drug reactions.
- *Health Information* – symptom based advice, electronic health information library and community service referral.
- *Corporate Health Management* – personal wellness and contact services.

Overall Trends

As the population continues to age, disease management is becoming more complex. This complexity is matched by the increase in specialized equipment, diagnostic tests and specialized medical knowledge required to treat these diseases and conditions. Furthermore, this trend can be applied to all other diseases as more information about disease pathology becomes apparent. Healthcare professionals in remote or rural medical practices are unable to deliver the same standard of care as that observed in larger centers since they do not have similar access to:

- specialized training;
- new and advanced medical equipment;
- volume of patients with similar conditions;
- other resources to draw upon including colleagues, seminars etc.

The Canadian government recognizes the disparity between rural and city healthcare delivery and the importance rural medicine as an integral part of the Canadian Healthcare system. They also understand that rural and First Nations medicine require different approaches to the community and delivery of care than urban medicine. For example, in 2002 CIHR initiated Rural and Northern Health Research (RNHR). This program is designed to develop integrative approaches to health service delivery in northern and rural settings.

The technological advances in electronics and communication have been advantageous to remote and rural medical practices. Specifically, ability to communicate with specialists, use advance diagnostic procedures and obtain assistance with complex medical procedures not only increases the type of care delivered to a remote location but also lessens the total costs of care provision. As these technologies advance, further opportunities exist to bring together groups of people that would not traditionally be associated in with each other. These include people within

the electronics, networking and robotics fields being brought together with health professionals and researchers to improve health delivery.

Enabling Technologies

CSTAR: Telesurgery – Robotic Telementoring and Telesurgery

<http://www.c-star.ca>

In a collaboration between London Health Sciences Centre and Lawson Health Research Institute (The University of Western Ontario) is using a Virtual Private Network (VPNe) provided by Bell Canada and TeleSat to connect to remote locations. Working over a 15 Mbps IP-VPN, Hamilton can connect their robotic console with the Zeus® –TS surgical robotic system at North Bay General Hospital. 21 telerobotic operations have taken place using this system¹³.

Call Centers

Over 8,000 jobs have been created within Northern communities since 2000 as a result of call centre operations. For example, 2,500 people are employed in Sault Ste. Marie by the call centre industry¹⁴. The call centre industry has been able to flourish in the North due, in part, to the world class communication infrastructure.

Signaling System 7 Technology.

Sudbury has advanced, digital switching infrastructure available, including signaling technology SS7 (Signaling System 7).

High Speed Networks.

The gigabit fiber optic networks called Ontario Research and Innovation Optical Network (ORION) and Canarie (Canada) networks high speed networks to share information between universities. Laurentian University was among the very first Ontario universities to link to ORION. Greater Sudbury communications implemented a 2,400 km fiber optic network with SureNet. AT&T, Bell Canada, Persona, Rogers, and Gateway Telephone, who are providing resources to ensure that the system remains world-class.

NEONet

www.neonet.on.ca

The Northeast communications network is designed to facilitate public-private partnerships to increase broadband and cellular access to Northeastern Ontario communities.

¹³ Anvari, Mehran MB, BS, PhD *; McKinley, Craig Bsc EE, Msc EE, MD +; Stein, Harvey BSc, MBA. Establishment of the World's First Telerobotic Remote Surgical Service: For Provision of Advanced Laparoscopic Surgery in a Rural Community. *Annals of Surgery*. 241(3):460-464, March 2005.

¹⁴ The National Post Business Magazine. May 2004, 57-67.

Potential Impacts

The emergence of new technologies, specifically communication-centered advancements, has greatly expanded the abilities of rural medical practices to take advantage of more specialized care. Telemedicine continues to expand into new specialties and diagnostics. This enables rural health professionals to have more specialized support as well as increasing the ease with which patients are treated at home or remotely. Companies developing telemedicine products and related infrastructure see the value in connecting remote communities with larger institutions. Furthermore, many opportunities exist for government, academia and industry to work together developing new technologies for healthcare delivery.

The creation and implementation of new technologies and processes to deliver healthcare remotely have wide ranging implications. These include increased efficiency for healthcare delivery and new job opportunities in such fields as engineering, manufacturing, clinical trials, biomedical research and rural health research.

HEALTH INFORMATION SYSTEMS

Health information systems encompass technology that is used to aggregate, store, transmit and access data by medical professionals. This technology facilitates the accuracy of information while aiding in the timely access to patient care.

Relevance to Northern Ontario

Healthcare professionals are placing greater emphasis on information received from diagnostic equipment to diagnose medical conditions. Moreover, an increasing number of healthcare professionals are involved in diagnosing and treating a patient's condition. Proper communication between care providers is critical to this type of specialized health delivery. Poor coordination of care has been associated with poor clinical outcomes. With the ever increasing emphasis of chronic disease management, healthcare delivery becomes more critical. A significant step towards promoting healthcare coordination is through the creation and management of electronic health records.

Northern Ontario is ideally suited to link hospitals together over vast territories. This region comprises 822,000 square kilometres and accounts for nearly 90% of Ontario's total land area but contains only approximately 7% of Ontario's population. This vast territory and diffuse population present challenges to ensure delivery of quality healthcare. Northern Ontario healthcare institutions have not only begun to recognize the benefits that health information systems can provide, but are leading the country in implementing these systems. By using these systems, healthcare providers can not only better manage their patients but create opportunities for out- or in- sourcing specific health related resources.

There are many aspects to creating an "on demand" health environment. The requirements include the necessary infrastructure, skilled personnel, demonstrated unmet needs as well as a willingness of the health communities and funding agencies to participate. Northern Ontario has many of these conditions that are ideal to maximize health information system implementation and use.

Existing Capacities

ELECTRONIC PATIENT RECORDS

NORad

NORad is a partnership between 10 Northern Ontario Hospitals that share a single PACS¹⁵ database including Sudbury and Timmins. By 2005 this partnership is expected to expand to 17 hospitals that will include North Bay and Sault Ste. Marie and will cover 100,000 people living across 150,000 square miles. This system allows physicians in remote locations to instantly access medical images any time and is the largest multi-user PACS installation in North America¹⁶.

¹⁵ PACs: Picture Archiving and Communication System are an image viewing, storage, retrieval and transmission systems for diagnostic MRI, CT and X-ray images.

¹⁶ <http://strategis.ic.gc.ca/epic/internet/infednor-fednor.nsf/en/fn01908e.html>

The Northwest teleradiology system's hub

Located at Thunder Bay Regional Health Sciences Centre, this system links all the regional hospitals in Ontario's Northwest with a centralized PACS and allows images to be viewed electronically from anywhere in the region and from any other partners on the North Network System.

electronic Child Health Network (eCHN)

<http://www.echn.ca>

This is Canada's first fully integrated electronic health records system. Many different health information systems integrate into eCHN and it is designed for medical professionals to access a patient's health records from birth to the age of 18. There are 5,300 users that access the system through hospitals, clinics, doctors' offices or rehabilitation facilities. Currently, 36 hospitals in Ontario including 9 in Northern Ontario participate in the network. The Ministry of Health and long term care (MOHLTC) has invested \$21 Million into this project and it will be used as model for an adult electronic healthcare system network. This network also includes a professional online forum (PROFOR) where medical professionals can continue their professional development.

North Eastern Ontario Network (NEON)

NEON is an electronic patient record system that integrates 7 partner corporations and 9 clinical sites. Sudbury PACS is currently being implemented at 7 hospitals and will be extended to cover the NORAD network. This network not only includes an integrated patient record system but also an integrated purchasing system and vendor negotiation system (for increase purchasing power), hospital fax solution, healthcare validation service and a shared data center.

Group Health

<http://www.ghc.on.ca>

Group Health is one of Canada's largest healthcare centers treating approximately 60,000 people in Sault Ste. Marie¹⁷. This center's electronic health records called the Electronic Medical Record stores information for approximately 45,000 patients.

Northern Diabetes Health Network (NDHN)

<http://www.ndhn.com/>

NDHN is creating electronic patient records specifically for patients with diabetes and related complications.

Overall Trends

In today's healthcare environment of long patient wait times, electronic patient records can reduce the inefficiencies by quickly transferring accurate knowledge between professionals while ensuring historical accuracy. Governments have recognized the importance and also the complexity of implementing systems. With such a large and costly challenge confronting many industrialized governments, the development of an electronic medical system has become a global challenge. For example, development and implementation of an electronic record system

¹⁷ <http://www.northernontariobusiness.com/displayHeadline.asp?282id115-pn=&view=22354>

for England's national health system is projected to cost \$75 billion over the next decade¹⁸. For Canada's 36 million people, an electronic patient record system is expected to cost \$10 billion to implement¹⁹. The Canadian Federal government recognizes the large scope and time required for this project and has stated a goal of covering 50% of Canada's patient population with electronic patient records by 2009.

Many governments recognize that this is a global challenge and are turning to regions that have successfully implemented these programs. For example, Orion Systems of Auckland, New Zealand successfully implemented an electronic patient records system in Australia. Due to Orion's success, they were selected to implement a system for the publicly funded Capital Health Region in Edmonton, Alberta²⁰. This electronic records system in Alberta serves more than 1 million patients and 2,000 physicians.

As healthcare information systems are becoming more prevalent, the requirements for specialized personnel to design, implement and administer such systems are constantly increasing. In Canada, a 31% decrease over 10 years in the number of health record administrators has been observed²¹. To fill this unmet need, George Brown College in Toronto has recently initiated a specialized course in their post-graduate Health Informatics Program specifically designed to train people to select, implement and manage electronic patient records²². Technical and graduate programs in Northern Ontario have the potential to work with many of the organizations working with electronic records systems to fill market demands for skilled people but also to develop ancillary products that could work in conjunction with these systems.

The new trend in health information systems involves not only patient records but also tracking medical products throughout the hospital system. For example, blood products must be tracked from the donor to the patient in order to maintain safety and integrity of the blood distribution system. In the US blood centers are tracking blood products²³. In Canada, Cognos of Toronto has been awarded the contract to track donor information²⁴. There will remain the need to track a variety of products not only throughout the broader health system but also within each hospital. Datalog, a small medical software company in Vancouver, is creating software to tackle such problems. They are creating tools to track blood samples and prescriptions medications within a hospital. Northern Ontario has an extensive health information technology infrastructure to work with local companies and personnel to develop similar products to facilitate timely patient care and reduce medical errors.

As health information systems become more centralized and complex and an increasing amount of patient data must be collected in order to make proper diagnosis there will be a greater need for skilled people and the right technology. Northern Ontario appears to have the information technology infrastructure along with the willingness to implement systems to further develop an information systems environment where new products and services could be developed and offered both locally and elsewhere.

¹⁸ <http://www.fcw.com/fcw/articles/2004/1206/web-ehr-12-07-04.asp>

¹⁹ <http://www.fcw.com/fcw/articles/2004/1206/web-ehr-12-07-04.asp>

²⁰ <http://www.orionhealth.com/news/systemAdopted.htm>

²¹ Canadian Institute for Health Information. "Health Personnel Trends in Canada 1993-2002".

²² <http://www.gbrownc.on.ca/Marketing/FTCal/caet/T402.html>

²³ <http://www.americasblood.org/index.cfm?fuseaction=display.showPage&pageID=205>

²⁴ http://www.cognos.com/news/releases/2000/rel_273.html

Enabling Technologies

Smart Systems Health Agency

<http://www.ssha.on.ca>

A province wide secure IT infrastructure that allows communication between doctor's offices, hospitals, labs, public health offices, pharmacies and community care centers. This network is used by:

- NORTH Network
- NEON
- Cancer Care Ontario
- Cardiac Care Network of Ontario
- Trillium Gift of Life (organ donation)
- Ontario Air Ambulance Base Hospital Program

Patient Archiving and Communication System

AFGA has installed their "state of the art"²⁵ multi-site PACS system called IMPAX MPI (master patient index) for NORad. Using Initiate™ Identity Hub™ software for enterprise master patient index (EMPI) the patient and health provider can be managed. This hub facilitates secure data sharing and medical records integration that is in compliance with the United States' Health Insurance Portability and Accountability Act (HIPAA).

Electronic Medical Record System

Group Health in Sault Ste. Marie has an electronic medical records system that uses an IBM P630 server, AIX operating system, BBX pro 5 database and supports 268 concurrent users.

Ontario Research and Innovation Optical Network (ORION) and Canarie (Canada)

<http://www.orion.on.ca/>

<http://www.canarie.ca>

ORION is a high speed fiber optic gigabit network connecting many Ontario research and healthcare institutions with Lakehead University and Sudbury Regional Network (SUREnet). This network is specialized for learning and research activities across Canada.

SUREnet - Sudbury Regional Network

<http://www.rno.on.ca/NETWORKS/NorEasta.html>

SUREnet is in partnership with public and private entities to ensure advanced networking capabilities within Sudbury.

²⁵ Highest Ranked EMPI product by KLAS Enterprises

Potential Impacts

The movement towards health information systems such as electronic patient records has impacts on a variety of fields both within and outside of the delivery of healthcare. Primarily, health information systems should enable health professionals to quickly access patient information. Centralizing patient information creates efficiencies that are apparent when patients must visit multiple health care providers while making the remote delivery of specialized medical care more practical. The use of electronic medical data creates many opportunities for clinical research. These include²⁶:

- generation of hypothesis to initiate clinical studies;
- information to plan clinical studies in terms of projected patient numbers, disease prevalence etc.;
- identification of patient eligibility for clinical trials and
- longitudinal assessment of patients during and after trial periods.

Electronic health information systems can also impact areas outside of health delivery fields. For example, patient privacy issues become a paramount concern as the ease of information access increases. This issue creates opportunities for ethicists, lawyers, health professionals and information technology professionals to work together in addressing these types of concerns. Regions at the forefront of medical information systems can work together with these diverse groups of professionals to address these issues as they become more apparent.

Implementing health systems across a region requires a variety of infrastructure. The creation and support of these systems creates opportunities within and outside the healthcare fields. For example, high speed networks and advanced telecom networks enable call centers to flourish but also create the infrastructure for telemedicine and electronic patient data storage and retrieval. This diversity creates new opportunities within the health research field.

²⁶ J Med Internet Res 2005;7(1):e4

ENABLERS OF GROWTH FOR THE HEALTH RESEARCH INDUSTRY IN NORTHERN ONTARIO

CANADIAN INVESTMENT IN BIG SCIENCE (INFRASTRUCTURE & PROGRAMS)

Traditionally, health research was mainly conducted through the initiatives and interests of clinical and basic researchers in universities and hospitals. With great advances in molecular biology, new opportunities warrant large multi-disciplinary teams. This has led to the creation of networks and large scale research initiatives. These are becoming the drivers and the enablers of health research and industry.

Overview of National Landscape

The advances of recent decades in molecular biology and cellular biology along with the ever increasing power of computers are transforming the medical research sector. New technologies are transforming the paradigm of medical research and soon will transform medical practices. The beginning of the century has seen the completion of the human genome sequencing, the clinical success of novel classes of drug such as kinase inhibitors and protease inhibitors, and biologics (namely monoclonal antibodies and recombinant proteins). Technological revolution in terms of discovery tools also had a dramatic impact on medical research, namely: high throughput screening, rational drug design, genomics, and proteomics. The coming years further promise a plethora of additional technological revolutions such as gene therapy, cell therapy, therapeutic and customized vaccines, metabolomics, nanotechnology, pharmacogenomics, and more. Not only are these technologies revolutionizing medical research, but they will also transform clinical practices.

Canadians and their government have realized the importance of the health industry as a driver for economic growth and improved quality of life. It is anticipated that biotechnologies will surpass the IT boom of the past decades in economic impact and societal transformation. In February 2002, a National Innovation Strategy was launched by the Canadian government; this strategy aimed to move Canada to the forefront of the most innovative countries by 2010²⁷. Targets set were to make Canada one of the top 5 countries in research and development performance and a leader in the share of private sector sales from new innovations.

The biomedical industry is a key pillar of the National Innovation Strategy.

“As the 21st century unfolds, the health sector is emerging as the largest and most important driver of the global economy. Some industry analysts predict that the growth rate in health related knowledge in the century ahead will exceed the growth rate that the information technology sector experienced in the 20th century. In fact, such predictions are the logical endpoint of the recent convergence of health science and information technology, which is driving recent advances in biotechnology.”²⁸

This initiative has impacted government budgetary choices. In the 2005 budget, the federal government as reiterated its desire to make Canada a leader in the knowledge economy, especially through leveraging Canadian assets in the biomedical industry and further developing our national capabilities in research and in the commercialization of our innovations. The 2005 budget comprises an additional \$375 million over five years for the three federal research

²⁷ <http://www.innovation.gc.ca>

²⁸ Health Research – the growth sector of the new economy: (<http://www.innovation.gc.ca>)

granting councils, \$165 million to Genome Canada and \$75 million over five years to help meet the indirect costs of research²⁹.

In this new era of health research, it does not suffice to support individual academic endeavour. The challenges that the health industry faces today warrant 'mega-projects' that are multidisciplinary, bring together several experts, and require sophisticated infrastructure. This is an era for 'Big Science'. This new paradigm demands different approaches and funding models. The establishment of the Networks of Centres of Excellence (NCE), of Genome Canada, the Canada Foundation for Innovation (CFI), and the National Research Council (NRC) Genomics and Health Initiatives; are all answers to this changing paradigm.

The National Research Council of Canada (NRC)

The first pillar of Canadian 'Big Science' is the institutes of the NRC. The NRC is the premier organization for federal research and development. Its organizational structure and mandate allows its scientists to undertake long and ambitious research endeavours that are not compatible with the traditional academic research model. Furthermore, the NRC mandate places its research activities at the convergence of academic research and industry R&D.

The NRC is composed of 20 institutes and national programs, of which 8 are involved in biomedical research and development:

Canadian Bioinformatics Resource (NRC-CBR)

The CBR is a resource centre dedicated to providing the research community with convenient and effective access to bioinformatics tools and databases.

Biotechnology Research Institute (NRC-BRI)

The BRI promotes, assists, and performs leading-edge research and development in biotechnology related fields such as biochemical engineering, molecular biology, structural biology, cellular biology, gene therapy, scale up of biologics productions, and other. BRI's activities are closely linked to the needs of industries in the biopharmaceutical and environment sectors. The institute has three departments: health, environment and the bioprocess platform.

Genomics and Health Initiative (NRC-GHI)

The GHI is a funding platform that was established in order to bring the benefits of genomics research and tools to Canadian health scientists. It provides a platform to bring NRC researchers together to leverage their expertise in multi-disciplinary endeavours that will provide leading edge tools and know-how that will benefit all Canadian researchers.

Institute for Biodiagnostics (NRC-IBD)

The IBD is involved in research and development of biodiagnostics. It develops non-invasive medical devices and techniques to improve medical practice through earlier diagnosis of diseases and better prognosis of diseases.

Institute for Biological Sciences (NRC-IBS)

The IBS conducts innovative research in the application of neuroscience and glycobiology science. It focuses on reducing the impact of age-related diseases as well as infectious diseases. Its research programs are carried out with industry partners, universities, hospitals, and other R&D organizations.

Institute for Nutrisciences and Health (NRC-INH)

²⁹ <http://www.fin.gc.ca/budtoce/2005/budliste.htm>

This new NRC institute is a joint venture with the Atlantic Canada Opportunities Agency (ACOA). It focuses on the role that naturally-occurring compounds that are found in plants and marine resources can play in optimizing health. INH scientists are involved in identifying these compounds and determining how they can be used to improve the health and disease prevention. Key research areas include neurological disorders, obesity-related disorders, infection, and immunity-related disorders.

National Institute for Nanotechnology (NRC-NINT)

NINT is the centerpiece of Canada's emerging nanotechnology sector. Established in 2001, it is an integrated, multidisciplinary research institution involving researchers in physics, chemistry, engineering, biology, informatics, pharmacy, and medicine. Funded by the Government of Canada, the Government of Alberta and the University of Alberta; and operated as a partnership of the National Research Council Canada and the University of Alberta, it carries out advanced research and fosters innovation in support of a new generation of nanotechnology-based firms.

Nuclear Magnetic Resonance (NRC-NMR)

The NMR was funded by a CFI grant and is managed through the University of Ottawa. It will provide Canadian scientists with a 900 MHz NMR spectrometer, the only one in Canada. This facility should be operational by spring of 2005.

Steacie Institute for Molecular Sciences (NRC-SIMS)

The SIMS institute is involved in cutting-edge molecular sciences. The SIMS undertakes interdisciplinary work with national and international partners. It works with universities, industry and other NRC institutes to provide leadership in the development of molecular science knowledge. Among its activities, it investigates the chemistry of biological processes.

The NRC activities are focused on technology transfer to industry. Since 1995, the NRC has created 52 firms based on its technologies, licensed many technologies, and collaborated with industry, university, hospital, and others. The NRC provides access to the world's science and technology for Canadian researchers and industry. The NRC's breadth reaches beyond Canada; it has collaboration agreements with research organizations in France, Germany, Spain, Taiwan, and the Czech Republic.

The NRC currently employs close to 4000 people across Canada. In 2002-3, it had a cumulative funding of \$77.8 million, had signed 326 collaborative agreements totalling more than \$100 million, and was engaged in 462 formal international agreements with private, public, and university partners.

Genome Canada

Genome Canada is an investment agency dedicated to "developing and implementing a national strategy in genomics and proteomics research for the benefit of all Canadians"³⁰. It has so far been allocated \$600 million, including funds committed in the 2005 budget. Furthermore, Genome Canada is also part of a \$95 million Canadian-led international consortium on structural genomics. The Structural Genomics Consortium (SGC) involves the United Kingdom, Wellcome Trust, GlaxoSmithKline and four Canadian organizations and is focusing its efforts on determining the three-dimensional structure of more than 350 human proteins. Other major international initiatives in which Genome Canada is involved are the Haplotype Map project and the Bovine Sequencing project.

³⁰ <http://www.genomecanada.ca>

Genome Canada now has a portfolio of 79 large-scale research projects and technology platforms. These initiatives have attracted some of the world's leading researchers. The technology platforms are:

- **The Genome BC Science and Technology Platforms**
This platform gives access to genomics and proteomics technologies and large-scale shared facilities for innovative genomics research. It provides capabilities for the analysis of massive amounts of data. This platform supports 11 large-scale projects including: Sequencing and Mapping, Bioinformatics, Technology Development, Proteomics, and Microarrays.
- **Proteomics Technology Core Facility**
This platform provides proteomics researchers with a state-of-the-art technology for proteomics research.
- **Genome Resource Core Facility & the Genome Quebec Innovation Center**
These two platforms give access to genomics and proteomics tools including robotics equipment.
- **DNA Sequencing Facility**
This platform supports the sequencing needs of Genome Atlantic's large-scale genomics projects.
- **An Integrated and Distributed Bioinformatics Platform for Genome Canada**
This platform hosts a bioinformatics platform that builds on existing infrastructure, including the Canadian Bioinformatics Resource of the NRC (NRC-CBR) and the Calgary-based Sun Center of Excellence for Visual Genomics.

In addition to these key platforms, Genome Canada has approved strategic projects all across Canada that include: cancer genomics, functional genomics, haplotype mapping, bioinformatics, stem cell genomics, proteomics, metabolomics, and many others.

The Networks of Centres of Excellence (NCE)

The NCE program fosters powerful partnerships between university, government and industry. These Networks mobilize research talent across Canada. It creates social and economic benefits for all Canadians. The NCE contributes to accelerate the exploitation of knowledge, research and technology, and to speed their transfer to the marketplace and to the public.

Ontario is responsible for 43.3% of NCE program expenditures, 39% of NCE researchers and 37% of highly qualified personnel. The projects under the umbrella of the NCE are:

- Allergy, Genes and Environment Network - AllerGen
- Canadian Arthritis Network - CAN
- Canadian Bacterial Diseases Network - CBDN
- Canadian Genetic Diseases Network - CGDN
- Canadian Network for Vaccines and Immunotherapeutics - CANVAC
- Canadian Stroke Network - CSN
- Protein Engineering Network - PENCE Inc.
- Stem Cell Network – SCN

While the Northern Ontario's Universities are not involved in the health-related network, they are active members of several of the other Networks of Centres of Excellence, namely the Advanced Foods and Materials Network - AFMNet (2003-2008); Automobile of the 21st Century - AUTO21;

Geomatics for Informed Decisions Network - GEOIDE (1998-2009); Intelligent Sensing for Innovative Structures - ISIS Canada (1995-2006); Micronet - Microelectronic Devices, Circuits and Systems (1989-2005).

The Canada Foundation for Innovation (CFI)

The CFI is a corporation dedicated to research infrastructure funding of Canadian research institutions. Its mandate is to "...strengthen the capacity of Canadian universities, colleges, research hospitals, and non-profit research institutions to carry out world-class research and technology development that benefits Canadians".³¹ The CFI has a budget of \$3.65 billion and can fund up to 40% of costs for research infrastructure. Among its 5 funding programs, the CFI has two programs that support 'mega-projects': the Innovation Fund and the Research Hospital fund:

The Innovation Fund targets initiatives of research infrastructure in priority areas that promote multidisciplinary and inter-institutional approaches, and that enable Canadian researchers to tackle groundbreaking projects.

The Research Hospital Fund targets research hospital-based projects that commit to innovative research and training. It supports large-scale infrastructure projects promoting multidisciplinary research involving biomedical and clinical research, health services, and population health research.

Outstanding research in Canada

Canada is a great place for the biopharmaceutical industry. All top 10 pharmaceutical corporations³² have divisions in Canada and are actively involved in either clinical research or both clinical and basic research. Canada is very dynamic and competitive in clinical trials. This is highlighted by the success of our Canadian leaders in the contract research organization sector, namely: MDS Pharmaceutical Services and Algorithm Pharma; as well as other international companies such as Quintiles and Covance.

Potential Areas for Future Growth

The biomedical industry has come to an era where its success depends on the breadth of interrelation with a multitude of experts and stakeholders in the industry. The challenges that are faced by the biomedical industry today require large scale initiatives and multidisciplinary teams. In such a context, the Northern Ontario health research industry would find the greatest opportunities in aligning its assets with current national initiatives. This would entail working in close collaboration with the NRC, joining health-related networks of excellence, initiating large-scale genomic ventures, seizing infrastructure opportunities from the CFI, and capitalizing on the competitive advantage of Canada in clinical trials.

³¹ <http://www.innovation.ca/about/>

³² Pfizer, GSK, Merck, J&J, Aventis-Sanofi, Astra Zeneca, Novartis, BMS, Wyeth, and Eli Lilly.

HUMAN RESOURCE DEVELOPMENT (SCIENCE AND TECHNOLOGY SKILLS)

Health science depends on highly qualified personnel (HPQ). While this is true for most sectors of the knowledge economy, it is even more palpable in the health industry where post-graduates form the core of this industry human capital.

Overview of National Landscape

The growth of the health sector depends on the availability of highly qualified personnel (HQP). In fact, scientific and technical jobs in the health research sector are occupied by people with a post-graduate level of education. Moreover, in many instances, a multidisciplinary background is needed, combining scientific expertise such as molecular biology and bio-informatics, biology and physics. Other skills and training combinations such as law and science or business and science are also needed.

In 2000, it was estimated that 10,000 individuals were working in the biotechnology industry in Canada, of which human health is the predominant sub-sector. It is noteworthy that the health industry is competing with other life science sectors for the limited pool of skilled human resource³³.

The Biotechnology Human Resource Council (BHRC) has listed human resources (HR) that are regarded as a high priority in the life sciences sector³⁴:

- Laboratory Techniques and Instrumentation
- Developing/Managing Strategic Alliances/Investor Relations
- Protecting and Managing Intellectual Property
- Quality Control/Quality Assurance
- Marketing Strategies
- Financial Management
- Good Laboratory Practices
- Market Research
- Product Development Process
- Bioinformatics & Laboratory Software
- Information Technology Management
- Process Development
- Regulatory Submissions and Compliance
- Good Manufacturing Practices
- Business Software

The Canadian government has recognized the need for Highly Qualified Personnel (HQP) in the health industry. The need for skilled professionals was stressed in the National Innovation Strategy, launched in 2002. Although Canada labour force is one of the most highly educated in the world (in 1998, more than 280,000 diplomas were granted by our colleges and universities, including some 4,000 doctorates), meeting the needs of tomorrow's economy remain a challenge³⁵. To meet the national objectives for 2010, the number of research personnel needs to double and the number of people with multidisciplinary backgrounds will need to increase.

³³ <http://www.bhrc.ca/career/reports/downloadable/pdfs/HRTrends2000.pdf>

³⁴ <http://www.bhrc.ca/career/reports/downloadable/pdfs/HRTrends2000.pdf>

³⁵ <http://www.innovation.gc.ca/gol/innovation/site.nsf/en/in04161.html>

The National Innovation Strategy proposed to tackle that challenge by:

- Increasing the number of graduates from Canadian universities and colleges by 5% yearly until 2010
- Increasing the number of highly qualified immigrants coming to Canada as permanent residents or temporary foreign workers by implementing the new Immigration and Refugee Protection Act and regulations and by improving Canada's performance at recruiting foreign talents
- Retaining and training the people already in the knowledge economy labour force by increasing the number of adults pursuing learning opportunities by 1 million.

This commitment of the federal government was re-iterated in the 2005 budget, which provides:

- \$398 million to enhance integration programs for newcomers to Canada
- \$125 million for the Workplace Skills Strategy that was launched in 2005 to support continuous training to help workers keeping pace with the constantly evolving workplace
- \$120 million over five years for the Special Education Program for First Nations children living on reserves.

Furthermore, to especially tackle the deficit in health care professionals, the 2005 budget include \$75 million over five years for the 10-Year Plan to Strengthen Health Care, which aims at improving the integration of internationally educated health care professionals³⁶.

Biotechnology Human Resource Council (BHRC)

To support Canadian stakeholders in the biotechnology and life science sectors, the federally funded BHRC provides surveys and reports on the industry to help understanding its human resource needs, trends and benchmarks. It provides courses and workshops for workers of the biotechnology industry, as well as customized surveys for stakeholders in the industry.

The Federal Economic Development Initiative for Northern Ontario (FedNor)

FedNor is an Industry Canada initiative that is dedicated to address the economic development needs of Northern Ontario. Among its programs it offers support for technological innovation, training, business management skills development, and entrepreneurship development.

Provincial program supporting human capital

The government of Ontario has been providing funding and community development programs. **The Ministry of Municipal affairs** provides several rural economic development programs that help rural communities to remove barriers to community development and economic growth by investing in projects that support sustainable rural economies and community partnerships. Increasing opportunities for skills development counts among the priorities of this program. **The Ministry of Economic Development and Trade** offers several services and programs to support skills development. With its Strategic Skills Investment (SSI) program, the ministry has provided \$96 million in support of training programs that totaled \$384 million in investments. Additionally, through its Ontario Centres of Excellence, it further supports training and development of highly qualified personnel. The **Ontario Biotechnology Cluster Innovation Program** has a \$20 million program to support initiatives that promote entrepreneurship. Furthermore, the **Health Professionals Recruitment Tour** is another component of the government's strategy that helps northern and rural communities in attracting health care professionals to remote and under serviced communities. **ScienceWorks!** is a dedicated biotechnology centre that has as its objectives: 1) Diversifying the economy of Sault Ste. Marie and Northern Ontario, 2) Developing science-related education and training opportunities, 3) Assisting in the creation of new science-based enterprises, 4) Public involvement and outreach, 5) Enhancing the biotechnology profile and image of Sault Ste. Marie and Northern Ontario.

³⁶ <http://www.fin.gc.ca/budtoce/2005/budliste.htm>

Existing Capacity in Northern Ontario

The Northern Ontario region already has several assets for HQP training in the health sector. The pan-Northern region is home to several Universities and Colleges which provide scientific training and expertise in numerous health-related fields.

Lakehead University

Since 1998, Lakehead University has offered an Applied Bio-molecular Science Program, with 23 and 34 students enrolled in 2002 and 2003 respectively. It also offers a Masters degree in public health and is considering offering a doctorate in life sciences. There were 522 students who graduated from engineering, science and health-related programs and obtained a Bachelor or Master of Science degree in 2002. Of those graduates, 17 students received science-related master's degrees. Lakehead University is well-positioned to provide high quality, well-trained students for the health research industry. It also offers formal laboratory and research methodology courses to its students.

Laurentian University

Laurentian University offers several programs directly and indirectly related to biotechnology. In terms of biotechnology and scientific training, the University's 2002 enrolment included approximately 300 students in agriculture/biological sciences, and over 500 in health sciences. Among others, sciences and engineering degree programs includes biology, chemistry, biochemistry, environmental earth science, and computer science. Laurentian University also offers several professional programs such as e-business science, commerce and administration, midwifery, native human services and nursing. At the graduate level, master's programs are offered in engineering, biology, chemistry, human development, nursing, and others. The University now has a Ph.D. program in Biomolecular Sciences. To further strengthen its biotechnology and science training programs, Laurentian University is partnering with Science North to offer a one-year graduate diploma in Science Communication.

Nipissing University

Research at Nipissing University offers science-related programs in biology and computer science among others. Master's programs will be developed within the next four years in biological science. The presence of on-site graduate students will significantly increase research capacity. The University has targeted science and research as a priority area for strategic investment.

Northern Ontario School of Medicine (NOSM)

The development of the Northern Ontario Medical School (NOSM) will significantly enhance the health and biomedical training and research capacity in Northern Ontario and will generate spin-off benefits for biotechnology across the region. The inaugural class of the Northern Ontario Medical School (NOSM) will commence in September 2005.

Canadore College

Canadore offers a nationally recognized Biotechnology Program consisting of two years at the college followed by a year of field placement. This program, which utilizes state-of-the-art teaching technology, offers direct entry into industry. Industry placements have included companies such as Cangene, Apotex, Hemosol, the MDS group of companies and various government agencies such as the Canadian Food Inspection Agency. Canadore's employment training encompasses several sectors of the industry including: research and development, clinical trials, manufacturing, quality control, and federal regulation. The biotechnology program at Canadore represents an integrated educational environment that spans several scientific disciplines including: cell biology, chemistry,

physics, molecular biology, genetics, biochemistry, microbiology, immunology, fermentation and bioinformatics. The highly qualified professors and instructors have industry and academic expertise in medical technologies, genomics, molecular cytogenetics and bioinformatics.

Cambrian College

Cambrian College provides students with a variety of programs and proposes a new degree in Biotechnology to be offered in partnership with the Northern Centre for Biotechnology and Clinical Research (NEUREKA!). It would further develop educational and applied research opportunities.

Employment opportunities for HQP in health in Northern Ontario

The Northern Ontario region hosts several organizations that offer great job opportunities for HQP trained in health sciences and related subjects. Not only do they allow graduates to find stimulating jobs that leverage their skills, training, and aspirations; they also offer further training and practical experience for HQP as well as a pool of human capital for the industry to grow upon. In the knowledge industry, employees' mobility is highly valued as it allows for cross-fertilization of experience and know-how. The following is a list of organizations, public and private, that offer employment opportunities in the health-related industry.

Genesis Genomics (Thunder Bay)

Genesis Genomics is a privately held biotechnology company developing a database of mitochondrial DNA (mtDNA) mutations associated with cancer staging and disease inception.

Group Health Centre (Sault Ste. Marie)

The Group Health Centre (GHC) has been conducting clinical trials since 1980. With the implementation of a comprehensive Electronic Medical Record (EMR) in 1997, its research program has expanded to include outcomes evaluation and chronic disease management. The EMR database is the backbone for the Centre's dynamic, evidence-based medical research in primary care. As a result, GHC has the largest primary care disease site registry in Canada consisting of 58,000 patients.

Molecular World (Thunder Bay)

Molecular World offers a full range of DNA services on both current and ancient DNA samples. Services include: paternity testing, forensic DNA testing, DNA sample banking, Forensics and genealogical testing, among others. Molecular World uses state-of-the-art DNA testing equipment including GeneAmp thermocyclers and an ABI Avant genetic analyzer. The facility is equipped with contamination control adhering to industry standards.

Northeastern Ontario Regional Cancer Centre (NEORCC) (Sudbury)

Apart from being a health care delivery organization, NEORCC is actively involved in experimental cancer research. Its activities include clinical trials of radiotherapy and chemotherapy; peripheral stem cell research; immunology, molecular biology, epidemiology, psychosocial and behavioral research; radiation, physics and dosimetry research; and image registration research. **The Tumour Biology Research Group** at the Northeastern Ontario Regional Cancer Centre was founded in 1996 in order to provide a critical mass of researchers in molecular and cellular biology for "translation" of basic research into clinical practice. The **Epidemiology Research Unit** conducts studies that determine and compare cancer incidence and mortality rates and identifies risk factors for various cancers in the Northeastern Ontario and specialized occupational populations. Other areas of research interest include studies related to cancer screening, program evaluation, and cancer survival. **The Clinical Research team** conducts clinical

trials from phase I to III in the areas of breast, lung, prostate, colorectal, gastric, head and neck cancers as well as acute and chronic leukemias, melanoma and sarcoma. Some of the major cooperative groups the team is affiliated with are the National Cancer Institute of Canada Clinical Trials Group (NCIC CTG), Radiation Therapy Oncology Group (RTOG) and the Ontario Clinical Oncology Group (OCOG). This team also collaborates on numerous pharmaceutical company studies. **The Department of Medical Physics** has been devoting efforts to more effectively utilize digital images in routine radiation treatment.

Northern Centre for Biotechnology and Clinical Research (NEUREKA!) (Sudbury)

NEUREKA! is committed to providing the Canadian and global markets with novel products and services in the areas of life sciences, especially in health care and biotechnology. Its areas of activities include clinical research, biomedical research and development, and environmental biotechnology.

Northwestern Ontario Cancer Research Institute (NWOCRI) to become ICR Discovery

NWOCRI is a partnership of Lakehead University, the Thunder Bay Regional Health Sciences Centre that hosts Northwestern Regional Cancer Care and the Northern Ontario School of Medicine to develop this research institute. The overall goals of the program are to increase the number of researchers in Northwestern Ontario and to establish collaborations nationally and internationally.

The Paleo-DNA Laboratory (Thunder Bay)

This is a state-of-the-art facility providing molecular and genetic testing services to the public and companies world-wide. The lab provides DNA sequencing, fragment analysis service and real-time PCR to researchers. In addition, it offers genetic testing including forensic analysis, paternity testing, genetic heritage testing and other custom testing. Its focus, however, is on highly degraded ancient DNA and mitochondrial DNA services. It is believed that the Paleo-DNA Laboratory is one of the top three in the world in terms of its mitochondrial DNA analysis and work on highly degraded ancient samples.

Regenerative Medicine Research Institute and Tissue Bank Initiative (Thunder Bay)

The Northwestern Ontario Technology Centre is coordinating a project to establish a not-for-profit organization in Thunder Bay that will procure and store cadaveric tissue and will undertake biomedical research to expand the therapeutic applications of cord blood stem cells for tissue regeneration.

Northgate Medical Clinic (North Bay)

The Northgate Medical Clinic was established in 1997 with 4 Family Physicians, an Internal Medicine Specialist, a Clinical Trials Coordinator and a Laboratory Technician serving approximately 10,000 patients. Services offered include primary care as well as follow-up care in Cardiorespiratory, Endocrine, Gastroenterology, Rheumatology and Respiratory. The Northgate Medical Research Team has participated in many Phase III and several Phase IV Trials.

ProBity Medical Research (North Bay)

ProBity Medical Research is involved in Phase II to Phase IV testing in biological and clinical research.

North Bay Research (North Bay)

North Bay Research, run by urologist Dr. Bernard Goldfarb, has been involved in Pharmaceutical Research since 1997 with trials ranging from Phase II to Phase III. In addition, North Bay Research is involved with medical device trials.

Northern Ontario School of Medicine (NOSM)

The new medical school will not only train graduate HQP (see above) but will also be an important employer of health science graduates. The research programs will include biomedical, clinical, public health, population health, epidemiological, psychological and social sciences and health services research.

Potential Areas for Future Growth

Despite its small population, the Northern Ontario region has built strong assets in health care related services and industry. It has strong institutions for the training of professionals for the health industry and has several private ventures that contribute and support the health industry. As the bio-pharmaceuticals and biomedical device industries are exploding due to technological advances and growing market needs, the Northern Ontario region and its new medical school is poised to benefit from the new economic outcomes of this sector of the knowledge-based economy. At the same time this will provide its community with better care and treatment options. Because of its remote geography, it is more challenging to attract HQP, however the new medical school and the accompanying job opportunities in the region will provide opportunities to train and retain local students that aspire to be part of the health industry.

INTELLECTUAL PROPERTY AND COMMERCIALIZATION STRATEGIES

The health industry, like most knowledge-based sectors strives to compete through innovation. Innovations require years of research, and commercial viability stand on robust markets to pay back initial investments and risks. This generally relies on solid intellectual property rights that enable innovators that have invested in research to recoup their investment. Commercialization strategies thus include approaches to invention disclosure, patent protection, and who owns the intellectual property. Furthermore, the scope of investment required warrants the involvement of professional investors who are capable of evaluating risk and investing in early stage ventures.

Overview of National Landscape

For the public to get the full value of its investment in research, resources need to be committed to channel researchers into identifying and exploiting commercial opportunities. For discoveries to translate into direct economic outcomes, resources are needed in:

- Identifying discoveries with commercial applications
- Properly protecting discoveries with robust patents
- Actively managing the licensing of the technologies or the spin-off of new firms to materialize these opportunities.

In Canada's *Innovation Strategy*, released February 12, 2002, commercialization was one of the key priorities. It aims at leveraging publicly funded research into commercial applications. The strategy lists several initiatives to be introduced and funded by the federal government³⁷. These are:

- Provide funding to universities and hospitals on a competitive basis to support the direct operating costs of technology transfer offices.
- Create a national Network of Knowledge Transfer, Incubation and Entrepreneurship, to foster regional and inter-regional cooperation in marketing IP efficiently and effectively, sharing knowledge about business incubation and promoting entrepreneurship.
- Support regional training programs for technology transfer professionals.
- Create a national system for raising early-stage private-sector capital for seed funding of businesses, similar to the Ontario Community Small Business Investment Funds.

The deficit in commercialization expertise and resources was recognized by the Natural Sciences and Engineering Research Council (NSERC), which established in 1995 the Intellectual Property Management Program. The Canadian Institutes of Health Research (CIHR) and the Social Sciences and Humanities Research Council (SSHRC) later joined the program that aims to accelerate technology transfer from public institution to industry. It provides funding to support activities related to intellectual property (IP) management including internship training programs and initiatives aimed at integrating and broadening IP management capabilities for organizations groups. Its objectives are:

1. Recruitment, training and development of personnel
2. Accessing and developing expertise, databases, policies and procedures
3. Conducting initial technology assessments
4. Protecting intellectual property
5. Marketing intellectual property
6. Developing business cases and plans

³⁷ <http://www.innovation.gc.ca/gol/innovation/site.nsf/en/in02403.html>

7. Demonstrating the commercial potential of research results
8. Outreach to potential users
9. Increasing researchers' awareness of intellectual property issues and opportunities
10. Networking across institutions to share expertise and marketing

The federal government has further developed several vehicles to promote the transfer of innovations toward commercial opportunities. These initiatives consist of:

- The Biotechnology Clusters
- The Innovation Portal - Technology Transfer
- The Federal Partners in Technology Transfer
- The Technology Partnerships Canada
- The National Research Council
- The NSERC - Technology Partnership Program
- The Technology Inflow Program

In its 2005 Budget, the federal government aimed at bolstering the technology transfer capabilities of public research institutions by increasing its support to indirect costs of research, which include technology transfer offices. It also provided \$10 million for the Canadian Youth Business Foundation. This foundation provides mentorship, learning resources, and some start-up financing.

Several federal agencies are supporting technology transfer

The Canadian Innovation Centre (CIC)

The Centre assists inventors, entrepreneurs, and companies that are involved in technological innovations. It offers consulting services such as:

- Assess technical strength
- Conduct market research
- Evaluate commercial potential
- Provide product and process engineering
- Deliver training, educational programs and material
- Promote international technologies available for license

The Canadian Technology Network (CTN)³⁸

This network regroups public organizations and industry associations to provide ready access to expertise, advice, and information on technological and business issues. It encourages interdependency among existing providers of support services and helps finding national and international sources of expertise.

NSERC Innovation to Idea (I2I) program

The I2I program enables the acceleration of pre-competitive development of technologies with high potential for commercial applications. Its objective is to promote the transfer of technologies to Canadian companies. It supports researchers with assistance in early stage of technology validation and market connection.

³⁸ http://ctn-rct.nrc-cnrc.gc.ca/about_e.shtml

The CIHR Commercialization Programs

The CIHR recent innovative commercialization strategy has three objectives to further strengthen Canada's research translation:

1. To mobilize research
2. To develop people
3. To build partnerships

To achieve these objectives, programs such as the Fellows in Commercialization Management allow recruiting recent MBA graduates to facilitate their professional development and to enable universities and affiliated hospitals to better manage the intellectual property arising from health research. It also offers grants for proof-of-principal studies as well as proof-of-principal partnership.

Internet Portals

The federal government provides an extensive list of internet resources for technological innovation, life science industry, and commercialization. Most of these sites are links through Industry Canada web sites. Two such key links are following:

Technology Transfer

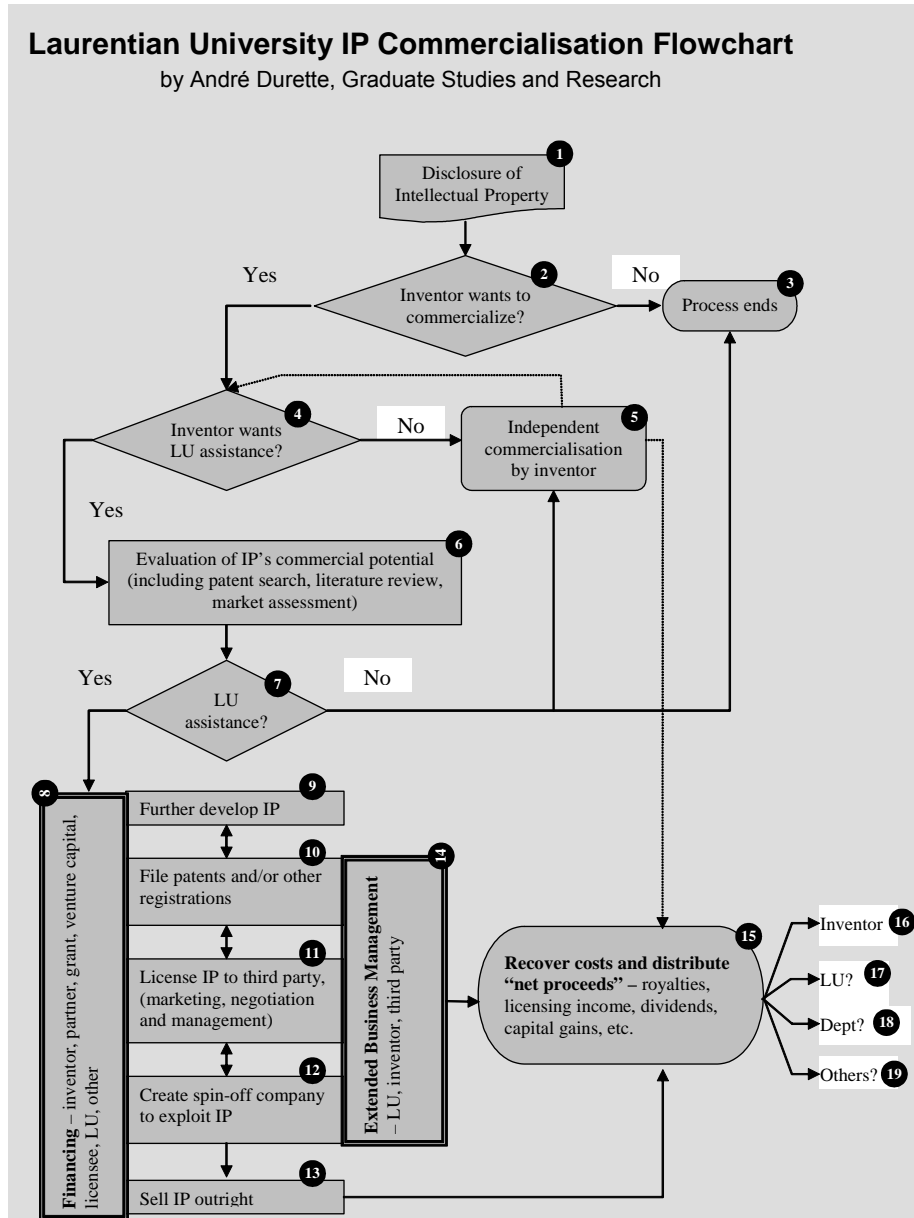
<http://www.innovation.gc.ca/gol/innovation/site.nsf/en/in02648.html>

Intellectual Property

<http://www.innovation.gc.ca/gol/innovation/site.nsf/en/in03619.html>

Existing Capacity in Northern Ontario

Commercial opportunities arising from research at the Laurentian University can benefit from the support of the Intellectual Property Management Office (IPMO). The IPMO has developed a detailed commercialization process that is presented below.



Reproduced from <http://www.laurentian.ca/intprop/documents.htm>

The IPMO provide assistance to its inventors for:

- The evaluation of an invention commercial potential including patent searches,
- Literature review, and market assessment
- IP development and filing
- Support for partners searches, licensing negotiation, etc

The IP policy at the Laurentian University provides an important incentive for its researchers to engage in technology transfer by entitling the inventors to get 50% of the net proceeds from the commercialization of their inventions.

At Lakehead University, the Innovation Management Office (IMO) is the body responsible for technology transfer and serves as the liaison between the several stakeholders in the commercialization process. The office is involved in:

- The management and commercialization of the intellectual property
- The handling of legal issues
- The development and marketing of innovations.

Similarly to Laurentian University, inventors can retained up to 50% of the commercialization of their inventions.

Northwestern Ontario Technology Centre

Beyond the university resource for the technology transfer, the region also benefits from the Northwestern Ontario Technology Centre that acts as a catalyst to:

- Create jobs by supporting technology-based entrepreneurs to establish and expand their businesses
- Contribute to the long-term economic growth of Thunder Bay and Northwestern Ontario
- Create conditions favorable for technology transfer to industry through development and commercialization of advanced-technology companies
- Encourage ongoing co-operation between business, education and government

International models for best practices in technology transfer

One of the most successful models for technology transfer, with a special focus on biotechnology is the UK model of the University of Cambridge. The booming of technological industry in the region is often referred as 'The Cambridge Phenomenon'. Of particular interest, it is noteworthy that the region only hosts a small population of just over 100,000 people and is a little more than 100 KM from London. The region had, in 1999, up to 150 companies in life sciences alone³⁹.

Cambridge excels in promoting industrial collaboration with research organizations and the University of Cambridge. A number of organizations contribute to the success of the Cambridge technological industry.

- The University's Wolfson Industrial Liaison Office, which manages collaborative agreements and intellectual property.
- The Cambridge University Local Industry Links (CULIL), which organize a wide variety of informal discussion groups bringing academics and industry together.
- The Cambridge Program for Industry (CPI), which specializes in training senior management and technical professionals.
- International collaborations and outreach initiatives, which links local researchers and industry leaders with international organizations stimulate technology transfer, provide an understanding of the industry needs, and generate beneficial collaborations.
- Very importantly, the University IP policy is one of the most favorable to inventors allowing them to retain up to 90% of net proceeds from the commercialization of their technology. This is a key factor in the success of this industry cluster.

³⁹ Lord Sainsbury, Biotechnology Clusters, Minister for Science, UK

Success factors for effective technology commercialization

Several key success factors for technology transfer offices and cluster development have been identified. In a study based on US research universities, 4 key drivers were demonstrated to correlate with increased success in technology transfer⁴⁰:

1. Experience of the technology transfer office
2. Concentration of technological firms
3. Focus and the leadership of the technology transfer Office
4. Greater reward for the inventors

Another study done for the UK's Ministry of Science has identified 10 such factors:

1. Strong science base
2. Entrepreneurial culture
3. Growing company base
4. Ability to attract key staff
5. Availability of finance
6. Premises and infrastructure
7. Business services and large companies in related industries
8. Skilled workforce
9. Effective networks
10. Supportive policy environment

The Association of University Technology Managers (AUTM)

The AUTM is a key association and resource center on technology transfer. It links technology managers from most North American universities and institutes. It provides several surveys and databases that allow comprehensive benchmarking to its members. It promotes training and education for technology transfer professional by providing internal and external educational training and communication programs.

The goals of the association are to:

1. Create broad understanding of the technology transfer process and its impact on society.
2. Develop and promote best practices in the profession.
3. Enhance the value of AUTM membership.
4. Communicate effectively with members.
5. Make AUTM an international organization.

Potential Areas for Future Growth

Drawing certain lessons from the Cambridge example, the Northern Ontario region could create a dynamic health industry that will stimulate economic development as well as social development by providing outstanding health care provision to its community. To do so it needs to assure that supportive infrastructure and support services are available such as: research infrastructure, policies and incentives favourable to inventors and entrepreneurs, commercialization support services, etc. In particular, favourable policies allowing inventors to accrue most of the benefits from the IP they create would set NOSM and Northern Ontario apart and provide a competitive advantage. This would be a key strategy to attract high-quality researchers to the area, who would be more likely to create 'spin-out' companies based on research at NOSM or other

⁴⁰ University Technology Transfer: Do Incentives, Management, and Location Matter?", Journal of Technology Transfer 28, January 2003, pp 17-30



academic centre in Northern Ontario. The economic and social returns for the community could be substantial.

FINANCIAL RESOURCES (GRANTS, VENTURE CAPITAL, TAX INCENTIVES)

Commercial ventures in health science, originate most often from academic science. Therefore, the first financial support of innovation is public and not-for-profit funding. The path from a discovery to its commercialisation further requires additional technological development for regulatory approval and market launch. This stage of commercialisation is high risk and time demanding. In the extreme case of drug development, an average of 12 years is required for a discovery to reach the market and generate revenues. This stage of development is poorly supported by public funds, thus risk-tolerant investors such as venture capitalists are the main fund providers along with “business investors angel” in the earliest stages of development. Governments are also present at this stage, however indirectly, through policies that promote private and public investments in R&D.

Overview of National Landscape

Grants

Funding for health R&D in Canada has increased significantly in recent years. In 2003, just over \$5 billion was spent in Canada for health R&D activities. Public funding of health research has significantly increased in the past 6 years after stagnating during the 1990s. In 2003, the federal government contributed 17% of all health R&D funding in Canada. Private investments from corporations have been an important driver of health R&D in Canada by contributing 30% of all R&D spending. It is noteworthy that corporations’ investments in Canadian R&D have been mainly targeted toward clinical research. Private not-for-profit organization such as charities and foundations are also important contributors to Canadian health R&D, contributing 8% of the health R&D effort. Canada compares well with other G8 countries in terms of investment in health R&D investments; it is however far behind the US, which invests 8 times more in health R&D per capita than Canada does.

The federal government is increasing its financial support to health research and its commercialization through programs such as the Canada Foundation for Innovation, Genome Canada, the Tri-Council (CIHR; NSERC; SSHRC), the Technology Partnerships Canada Program, Canada Research Chairs, and Canada Graduate Scholarships. Below is a comprehensive list of federal government programs that support health research and the health industry:

Canada Research Chairs (CRC)

The program funds the creation of research chairs in Universities all across the country. It aims at supporting outstanding researchers for senior position that will drive the universities or institutions to achieve their strategic goals.

Canada Foundation for Innovation (CFI)

This foundation has a mission to build Canadian research infrastructures in universities, colleges, and hospitals. It funds up to 40% of the infrastructure cost of projects. Costs that are eligible include state-of-the-art equipment, buildings, laboratories, and databases required to achieve research goals. The foundation proposes several programs:

- The Innovation Fund: for research infrastructure in priority areas that promotes multidisciplinary and inter-institutional approaches.
- The New Opportunities Fund: for infrastructure to support new recruits

- The Infrastructure Operating Fund: for contributing to the incremental operating costs that result from other CFI funded projects
- The Canada Research Chairs Infrastructure Fund: for providing infrastructure that supports to the Canada Research Chairs.
- The Research Hospital Fund: for research hospital based projects involving research and training. It can involve basic biomedical research, clinical research, health services, and population health research.

Canadian Health Services Research Foundation

This foundation supports research in the management and policies relating to health services and nursing. Several types of award are available including: Chair Awards, Regional Training Centres Awards, Postdoctoral Awards, Career Reorientation Awards, Regional Partnerships Awards, and the Health Services Research Advancement Award.

Canadian Institute for Health Information

This agency provides high quality and reliable health information. It funds proposals relating to Canadian population health initiatives that focus on the understanding of factors that impact the health of the Canadian population.

Canadian Institutes of Health Research (CIHR)

The CIHR is the premier health research agency in Canada. It funds research in all areas of health science. It provides operating grants in basic research, clinical research, and outcomes research. It also provides funding for salaries, fellowship, scholarship, industry partnership program, and knowledge translation. It is noteworthy that it offers grants for proof-of-principal studies as well as proof-of-principal partnership. The CIHR total budget for 2004-2005 is close to \$700 million.

Canadian Medical Discoveries Fund Inc.

This fund supports a broad range of projects both public and private that target health care improvement such as life sciences, biotechnology, diagnostics, medical devices, drug discovery and development, health care delivery services and e-health. It has two Ontario dedicated programs:

- The Early Stage Fund that targets health sciences businesses engaged in the early stages of technology development.
- The Venture Fund that targets health sciences businesses engaged in the late stages of technology development.

Genome Canada

Genome Canada funds large-scale projects in the field of genomics, and proteomics. Its objectives are to build technological capabilities and platforms to support leading edge research in Canada relating to the technologies that leverage the opportunities unique to the genome era that we have just entered.

Health Canada Funding Programs

Health Canada proposes funding programs that have specific objectives in support of telehealth, electronic health records, and implementation of information and communication technologies in the health sector.

National Research Council Canada external programs

- The IRAP funding programs that provide assistance in pre-commercial technological projects
- The NRC-BC S&T Fund that grants the Researcher Exchange Awards

Natural Sciences and Engineering Research Council of Canada (NSERC)

The NSERC provide operational grants, fellowships, and scholarships for university-based research projects in fields including biotechnology and life science. The NSERC also provides programs for industrial partnership, and technology transfer initiatives. The NSERC will invest \$850 million in 2004-2005 in research funding.

Networks of Centres of Excellence (NCE)

The NCEs' mission is to support multi-sectoral programs that foster partnerships between university, government, and industry. It seeks to stimulate entrepreneurial talents to translate innovation into economic and social benefits for Canada.

The Physicians' Services Incorporated Foundation

This foundation supports research that will directly address patient care problems, have direct relevance to clinical practice, and that will directly impact patient care. Such research may consist of:

- Clinical research
- Medical education research
- Health systems research
- Community-based research.

Science and Technology Program from the Department of Foreign Affairs and International Trade

This program aims at the facilitation of international collaboration. It funds research involving international team as well as provides scholarships and fellowships for international training.

Social Sciences and Humanities Research Council of Canada (SSHRC)

The SSHRC is dedicated to funding research in social science. Some of its program targets research on health care related issues.

Technology Partnerships Canada (TPC) Program of Industry Canada

This program is a joint program that brings Industry Canada and the NRC-IRAP into providing support to small and medium technological enterprises. This program provides repayable contributions for pre-commercialisation high technology development projects. The TPC program provides both expertise and financial assistance of up to \$3 million.

Charitable foundations

There are more than 5,500 not-for-profit and charitable agencies dedicated to health and health research in Canada. Together, they provide more than \$300 million annually for health R&D. The three largest funders of health R&D—the Heart and Stroke Foundation of Canada, the Canadian Cancer Society, and the Arthritis Society—reported a combined health R&D expenditure of nearly \$100 million in 2003.

Venture Capital (VC)

The nature of health innovation generally and drug discovery in particular, requires large upfront investments, while the returns may take many years to manifest. Moreover, technological and business risks are generally high. These undertakings require investors who are not risk averse. Therefore, the principal capital providers in health innovation have been venture capital funds.

In 2004, Canadian VCs invested \$445 million in health related industries, which represent 25% of their total investments. Ontario collected 45% of this total⁴¹. In Ontario, there are 13 VC firms with dedicated funds for Canadian life science ventures, twelve of which are in Toronto. They are listed below with their investment preferences:

1. Canadian Medical Discoveries Fund Inc.
(Seed, start-up; <\$500 thousand & >\$5million)
2. Genesys Capital Partners (Seed, start-up, expansion; \$1m to \$5m)
3. Kilmer Capital Partners Limited (Expansion; >\$5m)
4. MMV Financial Inc. (Expansion; \$1m to \$5m)
5. MWI & Partners (\$1m upwards)
6. Pinnacle Capital (Seed, start-up; <\$500K & \$1m to \$5m)
7. Scotiabank Private Equity Investments (Expansion, acquisition; \$1000K-\$5000K & >\$5000K)
8. TD Capital (Seed, start-up, expansion; >\$5m)
9. Teachers Private Capital (>\$5m)
10. Terra Capital Corp (<\$500K & \$1m to \$5m)
11. VenGrowth Capital Partners Inc. (<\$500K & \$1m to \$5m)
12. Wellington Financial LP (Expansion, acquisition; \$1m upwards)
13. Wifleur Inc. (Expansion, acquisition; \$500K to \$1m & \$1m to \$5m)

Other venture capital funding exists through the Labour Sponsored Investment Funds, of which 54 are currently registered. These funds are important source of capital for commercial venture arising from universities and hospitals. Altogether, these funds were investing \$350 million in Ontario businesses in 2002.

Tax policies

The federal government has endeavoured to create a more competitive corporate tax system in recent years⁴².

- It reduced corporate income taxes.
- It eliminated the federal capital tax.
- It reduced taxes on small and medium-sized businesses

⁴¹ <http://www.cvca.ca>

⁴² http://www.fin.gc.ca/toce/2003/svcc_e.html

The federal government also endeavours to promote entrepreneurship and venture capital investments by reducing capital gains tax, expanding tax-free capital gains rollovers for investments in small businesses, eliminating eligible investment limits for the period of reinvestment and removing impediments for pension funds investment into VC funds⁴³. Finally, a 20% tax credit is also available for R&D expenditures; a credit that is raised to 35% for smaller Canadian-controlled private corporations.

Existing Capacity in Northern Ontario

Grants from the Government of Ontario

Ontario Innovation Trust: This fund is for capital costs of research for Ontario's universities, hospitals, colleges, and research institutes. It is often used for the matching of CFI funding.

Ontario Research Performance Fund: This fund is dedicated to cover indirect costs associated with Ontario-funded research and is providing \$32 million a year to colleges, universities and research institutes.

Venture Capital financing in Northern Ontario

Northern Ontario historically recorded only a limited amount of venture capital investment. A total cumulative investment of \$20.4 million was recorded in Northern Ontario between 1996 and 2003, across all sectors⁴⁴. Sault Ste. Marie and Elliot Lake were the main recipients of Northern Ontario venture capital activity.

However, some funding programs dedicated to Northern Ontario attempt to fill the void. Such programs are:

The Federal Economic Development Initiative for Northern Ontario (FedNor)

FedNor is a federal initiative that is dedicated to support economic development in Northern Ontario. It works with numerous partners to provide support for community projects. It provides funding and a variety of business services. While FedNor does not typically fund private businesses, it is managing the Community Future Program that combines the local Community Future Development Corporations (CFDC) which provide financing to private firms. Nonetheless, within its Innovation program, FedNor will provide some financing to small enterprises. The Innovation program and services are intended to accelerate movement towards the knowledge economy. The program addresses applied research, general innovation, capital projects and non-capital projects. FedNor invests more than \$45 million a year directly into its programs and services. It includes a wide-range of programs for industry partnerships.

The Northern Ontario Heritage Fund Corporation (NOHFC)

This fund provides funding to not-for-profit projects and assistance to the private sector as well. The NOHFC is returning to its mandate to foster private sector job creation and economic development along with its role in helping Northern communities' economic growth initiatives. The NOHFC includes programs such as the Northern Ontario Young Entrepreneur Program and the Emerging Technology Program among others.

⁴³ http://www.fin.gc.ca/toce/2003/cantaxadv_e.html

⁴⁴ <http://www.cvca.ca>

Northern Ontario Grow Bonds

The Ontario government has established a pilot program to issue provincially guaranteed bonds and to use the proceeds to provide loans to new and growing businesses in northern communities. This project aims at encouraging northern Ontario residents to invest in their communities. The proceeds of provincially guaranteed Northern Ontario Grow Bonds are loaned to eligible small and medium-sized businesses in the North to strengthen and diversify the local economy. The objectives of the Grow Bonds Corporation are:

- To foster business development in Northern Ontario
- To provide debt financing to be used by eligible businesses and eligible entities for such purposes as may be prescribed by the regulations
- To engage in such other activities as the Lieutenant Governor in Council may specify for the economic benefit of Northern Ontario

Potential Areas for Future Growth

To make the most of local opportunities, local sources of capital, such as business angel networks should be set up. Venture capital firms like to invest in organizations that are in fairly close geographic proximity to facilitate the management of those investments. For to the region to best support its entrepreneurs, better channels for accessing private funding are needed.

NEXT STEPS – BUILDING FROM A STRONG FOUNDATION

The Northern Ontario School of Medicine (NOSM) has initiated this study to ascertain the opportunities to build a health research economy in Northern Ontario. This document acts as a starting point to gather more information as to resources, initiatives and health related opportunities within Northern Ontario.

The next step in the information gathering process will be the regional meetings held during the first two weeks in May. These meetings are designed to solicit additional information relevant for the building of a vibrant health research industry as well as your perspective and opinions. Your participation in this process is paramount to the understanding of your priorities, issues and objectives that would make this project a success.

Starting with your community's participation in the regional meetings, information collection will continue for the next 3 weeks. Once collected, a series of strategic options will be developed and brought forward. By early June your opinion will be sought to discuss and prioritize the strategic options. This process is intended to involve you and your community as much as possible since it is the aim of this project to develop a plan that will allow all regions to succeed.