

A REPORT FOR THE CANADIAN RADIOLOGICAL FOUNDATION

Medical Imaging in Northern Canada: A Snapshot in Time



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Executive Summary

Consistent with its mission "to promote the art and science of radiology through research and education," the Canadian Radiological Foundation (CRF) has undertaken this project to investigate the status of diagnostic imaging in Northern Canada. The CRF will share these findings with the Canadian Association of Radiologists (CAR), with the expectation that both organizations will work to further the development of imaging services in Canada's North.

The delivery of diagnostic imaging services in the three territories exemplifies many challenges associated with small departments serving rural and remote areas. Medical imaging departments in Northern Canada are further challenged by harsh climate, rugged geography, limited travel infrastructure, rapid cultural and economic change, and populations with a life expectancy rate that is below, and an infant mortality rate that is above, the rest of Canada.

The diffusion of imaging technologies in the territories is greater than in the rest of Canada due to travel constraints and the need to make technologies as accessible as possible in rural and remote areas. In all three territories imaging technologies, though limited in range, are reasonably up to date. While imaging technologies may be current at this point in time, the Yukon and the Northwest Territories stated a need for a plan which will articulate future imaging needs. Such a plan would ensure that capacity for each modality, equipment, staffing and space needs are anticipated in advance of when they are required, and that funding could be set aside.

No territory provides all imaging modalities to its residents and it was not possible to access information concerning the number of residents who travel to southern destinations for imaging examinations; therefore it was not possible to fully explore diagnostic imaging utilization in Northern Canada. The territories differ greatly in the number of general radiography, ultrasound and CT examinations that they provide per capita. Based upon the Consultant team's past experience, the Northwest Territories appears to deliver a large percentage of the imaging examinations provided to its residents, whereas Nunavut appears to deliver a relatively small proportion of the examinations provided to its population.

Recent projects to introduce PACS and enhance the telehealth systems in the Yukon and Northwest Territories have served to enhance the quality of imaging in a number of ways. Digital storage of images and electronic transmission of images from site to site for interpretation and reporting have provided more flexibility and alleviated some difficulties associated with maintaining radiologists onsite. Electronic transmission of images has also improved patient care by reducing the time from examination to report. Digital storage of images has improved quality of images and eliminated some of the difficulties associated with developing film in very cold climates. Nunavut has recently embarked upon a similar project and expects to see the same benefits by 2012.

All territories share a number of concerns related to the diagnostic imaging workforce, such as recruitment and retention of technologists. The lack of locum staff could potentially be offset if a casual pool common to all three territories were developed. Such a pool would not only alleviate staffing deficiencies, but could start to introduce common standards and practices amongst the hospitals and regions.

In community health centres in the Yukon x-rays are delivered by nurses, whereas in the other two territories they are delivered by a combination of nursing and non-nursing staff. Currently, nurses in health centres in the Yukon do not have any type of formal x-ray training program. Basic x-ray workers in health centres in Nunavut's Baffin region have recently lost their training program and those in heath centres in the Northwest Territories are trained by a local college, but only on an ad hoc basis. Enhanced training opportunities for basic x-ray workers in Canada's North could serve not only to enable staff to increase their scope of work, but also to expand and standardize quality practices. There is a stated need to develop a set of competencies for the delivery of imaging services in rural and remote areas. Also, the development of web-based modules that could supplement other forms of on-site training is thought to be one way to assist with basic radiography workers' learning needs.

The requirement that radiologists apply for additional licences for each province and territory appears to be limiting the number of type of radiologists who are willing and available to perform locum work in the territories. Universal Canadian licensure would undoubtedly serve to improve radiologist coverage in Canada's North.

One deficiency that became obvious through the project was the lack of time available to supervisors/managers, especially those who also have responsibilities to patients. These individuals do not appear to have sufficient time or other resources available to assist them in planning or other administrative functions, in part because patient care always remains their priority. The development of collaborative work efforts within and across territories could serve to lessen time demands upon individual managers.

Some opportunities became apparent through involvement with this project including:

- Assistance with planning for the future including: the capacity projections for each modality; the costs and benefits associated with the potential acquisition of new technologies; equipment replacement and upgrade requirements; projected staffing requirements; and associated space needs.
- The development of collaborative equipment purchase and maintenance programs.
- An inter-territory human resource initiative that might serve to investigate and improve recruitment activities, develop a common locum pool, and investigate and establish requirements that are needed to retain staff.
- An inter-territory initiative that would establish competencies associated with the delivery of basic x-rays in rural and remote settings.
- The development of web-based modules to supplement on-site basic x-ray worker training. These would focus upon practices associated with performance of x-rays and standards associated with radiation protection and image quality.
- Assistance in the development of quality standards and a methodology that could serve in the rural and remote communities across all territories.
- An initiative to investigate options and to advocate for the development of universal Canadian licensure for radiologists. This initiative might also advance the practice of remote "reading" of imaging examinations by investigating and clarifying licensing requirements when exams are "read" in a jurisdiction other than that where the examination was performed.
- An inter-territory initiative that might explore options for the delivery of continuing professional development programs across all territories, perhaps in conjunction with national and/or provincial professional associations.

Acronyms and Abbreviations

BA Barium Studies

CAMRT Canadian Association of Medical Radiation Technologists

CAR Canadian Association of Radiologists

CHI Canada Health Infoway

CLXT Combined Laboratory and X-Ray Technician

CRF Canadian Radiological Foundation

CR Computed Radiography
CT Computed Tomography
CVA Cerebral Vascular Accident

DI Diagnostic Imaging
DM Digital Mammography
DVD Digital Video Disk
EHR Electronic Health Record

ER Emergency Room/Department
FPTRPC Federal Provincial Territorial Radiation Protection Committee

FSHC Fort Smith Health Centre FTE Full Time Equivalent

HHWMH H.H. Williams Memorial Hospital

GI Gastro-intestinal
ICU Intensive Care Unit
IRH Inuvik Regional Hospital

km Kilometre

LPN Licensed Practical Nurse
MIC Medical Imaging Consultants
MRI Magnetic Resonance Imaging
MRT Medical Radiation Technologist
NICU Neonatal Intensive Care Unit

NIHB Non-Insured Health Benefit (Program)

NT Northwest Territories

NU Nunavut

OAMRT Ontario Association of Medical Radiation Technologists

OR Operating Room

PACS Picture Archival Communication System

PCB Polychlorinated Biphenyl QA Quality Assurance

QGH Qikiqtani General Hospital RIS Radiology Information System

RN Registered Nurse
SAN Storage Area Network
SBFT Small Bowel Follow Through
STH Stanton Territorial Hospital

US Ultrasound

VPN Virtual Private Network
WGH Whitehorse General Hospital
YHC Yukon Hospital Corporation
YHSS Yukon Health and Social Services

YK Yukon

24/7 24 hours per day, seven days per week

The Issue

Radiology has seen significant advancement over the past 25 years, a large part of which can be credited to ongoing research. Research will continue to be integral to the field of radiology to ensure that it advances further and continues to contribute to the Canadian health system.

The mission of the Canadian Radiological Foundation¹ is "to promote the art and science of radiology through research and education". In line with this mission and to celebrate its 20th anniversary, the CRF was to undertake projects that aid in the support and development of diagnostic imaging, in Northern Canada and in the Third World. The CRF will share the findings with the Canadian Association of Radiologists, the national voice of radiology with a commitment to promoting quality imaging for all Canadians. The CRF fully supports the CAR in its activities and expects that this report will be used by both organizations to further imaging services in Canada's North, and to provide fund raising opportunities to help with this work.

The decision to investigate diagnostic imaging services in Northern Canada is timely as 2007-2008 was designated an International Polar Year² with specific focus upon researching Arctic human health. Northern Canada comprises a significant portion of the circumpolar region and its population shares similar health concerns with those of other Arctic populations. This Arctic Human Health Initiative will serve to increase visibility of human health concerns, revitalize cooperative research, and develop strategies to improve the health and well being of Arctic residents.

The CRF initiative investigates the status of medical imaging in Canada's northern territories, an area where the delivery of health care meets unique challenges and available resources are limited. ProMed Associates Ltd was asked to help establish current medical imaging service delivery in the Yukon, Nunavut and the Northwest Territories and also to learn about the conditions under which imaging services are delivered. This information could then be used as a basis for further discussion and potential collaboration to assist in ensuring that the needs of the population, as well as care providers, are met in both the short and long terms.

Report Purpose

The strategic objective of this report is to increase the Canadian Radiological Foundation's understanding of the delivery of medical imaging services in Northern Canada and to identify areas of potential collaboration with stakeholders in Canada's three territories. This report addresses a number of key questions:

- 1. What medical imaging modalities³ and services are provided in Northern Canada?
- 2. Where and how are these services provided?
- 3. How is teleradiology being applied to meet current needs?
- 4. Which medical imaging services are referred elsewhere, to where and why?
- 5. Who and what are brought in to help address imaging needs (and in what rotations)?
- 6. How much is done in this manner?
- 7. How are these services paid for?
- 8. What are the current staffing situations for radiologists and technologists?
- 9. How are educational requirements being met?

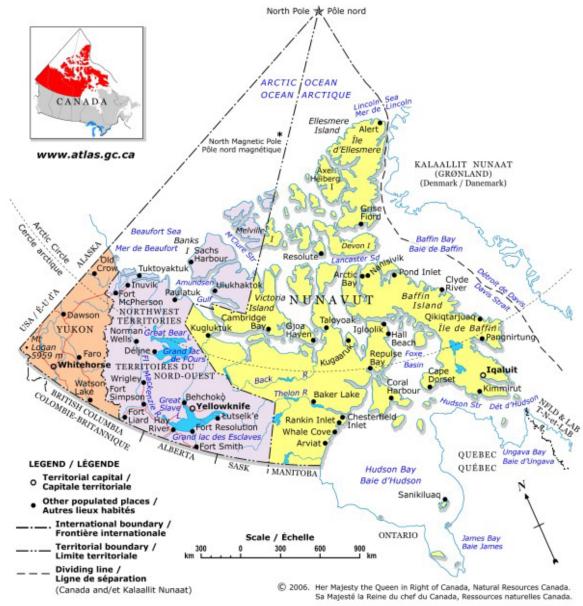
¹ http://www.car.ca/content.aspx?pg=Foundation&spg=about&lang=E&IID=

² The International Polar Year 2007-2008; The Arctic Human Health Legacy, A.J. Parkinson, Alaska Medicine Supplement.

³ Includes x-ray, CT, NM, US, and MRI technologies

Background

The Yukon, Northwest Territories and Nunavut encompass Canada's land mass north of the 60th parallel of latitude. To the west, the Yukon is bordered by Alaska and to the north, by the Beaufort Sea. The north of the Northwest Territories and the north and east of Nunavut are characterized by miles of rugged coastline bounded by various bodies of water, the Arctic Ocean being the most northerly (see map below). The northern territories cover a vast area, nearly 3,548,000 square kilometres. In 2006 the total population of the three territories was reported to be only 101,310.



Natural resource development, especially mining, is the major industry in all three territories. Other significant employers include tourism, government, and various forms of sales and service, and trade and transport industries.

The territories share some characteristics that together create unique challenges for the delivery of health care services to residents of Northern Canada⁴:

⁴ The information in this section comes from Statistics Canada Census 2006

- Low density population: The three territories encompass 39.3 percent of Canada's land mass and yet provide homes to only 0.3 percent of its population. More than 49 percent of their inhabitants are classified as living in rural or remote areas⁵. On average, 0.029 people reside per square kilometre, compared with Canada's average of 3.5 people. As a result, not only do many residents suffer geographic isolation, but it is impossible to achieve economies of scale and it becomes more difficult and expensive to deliver services to such a widely dispersed population.
- Lack of transportation infrastructure: Many small communities are now connected to larger cities by air; however, road transportation remains a barrier to the access of health care, especially in harsh winter weather. In Nunavut, with only one short road, communities are accessible by only air or ocean. Undeveloped road systems also impede the transportation of major equipment and supplies.
- Harsh weather and geography: The cold, icy conditions that prevail for much
 of the year compounded by rugged geographical features further limit travel
 and access to larger centres and towns. For example, until the new Deh Cho
 Bridge is completed in 2010, access to the Stanton Territorial Hospital in
 Yellowknife is not possible from the south during freeze-up and melt-down
 due to lack of a secure means to cross the Mackenzie River.
- Limited resources: Costs such as those associated with the transportation of supplies and equipment, staffing, and patient transfers cause the territories to have a higher per capita health care cost than the rest of Canada. In 2003 Nunavut reported spending almost \$3 million per week on health care, with 25 percent of that consumed in the transfer of patients to centres in the south. This amount represented 3.6 times the average per capita health care cost in Canada. With a funding system which is primarily based on federal transfer payments and the territories each having relatively small populations, health care dollars have to be stretched far further than in the remainder of Canada.
- Challenges in recruiting and retaining trained staff: Health care workers in very rural regions experience demanding workloads and related stress.
 Typically the workforce is understaffed with high turnover rates. It is difficult to recruit and retain clinical and technical professionals in remote northern communities.
- The need for cultural sensitivity: The huge cultural diversity within the territories leads to different expectations and different accepted practices relating to lifestyle and health care. In turn, this calls for sensitivity to these differences and integration of Aboriginal culture and traditional and alternative medicine at every level of care.

Although health care determinants are reported to have improved over the past 50 years, their life expectancy rate remains below, and their infant mortality rate remains above, these rates for residents of Canada's ten provinces. In particular, the health status of the Aboriginal population is reported to be markedly different than that of the non-Aboriginal population. Recent health indicators show that the health status of residents in at least two of the three territories is not as good as the Canadian average with respect to:

- Life expectancy (years)
- Infant mortality
- Hospitalizations due to injuries

⁵ Note: "rural" is defined as living outside centres with 1000 people or more or living outside a region with more than 400 people per square kilometre.

- Self rated health as excellent or very good (Nunavut only)
- Self rated mental health as excellent or very good (Nunavut only)
- Obesity
- Asthma
- Regular alcohol use
- Regular smoking
- Suicide rate
- Hospital admissions for ambulatory care sensitive conditions⁶
- Knee replacements
- Incidence of cancer (Nunavut only)

Some environmental factors are expected to continue to challenge the health and well-being of Arctic residents⁷:

- Changing culture: The large component of the population of the three territories having an Aboriginal identity has traditionally lived close to the land with an economy based on subsistence hunting and gathering. Over the past few years there has been significant growth in the development of natural resources which in turn is changing the territories' economy into one based on cash and dependent upon the global economy. The shift in the Aboriginals' way of living and in their traditional practices can be expected to result in loss of cultural identity and self esteem, which may then lead to social and mental distress.
- Rapid change: resource development may have served to improve housing conditions, improve supplies of food and other essentials, but it is also serving to increase the prevalence of chronic diseases such as diabetes, hypertension and cardiovascular disease and in areas that have recently been opened to air travel, an increase in infectious diseases.
- Environmental contaminants such as mercury, other heavy metals, dioxins, and PCBs have migrated to the Arctic via atmospheric, river and ocean transport. Their appearance in food and water leads to concerns of damage to brain, endocrine, immune and cardiovascular systems.
- Climate change: Inhabitants with a traditional lifestyle who rely upon the land for food may witness changes in areas such as animal migration patterns, travel conditions, distribution of various diseases and safe water supplies. In turn, these changes in lifestyle may increase mental and social stress.

There is general agreement that in the ratio of physicians to population decreases as a community becomes more rural, and declines very significantly for remote locations; however this is not the case for the Yukon (YK) which is considered largely rural yet there are 230 physicians per 100,000 people compared with the Canadian average of 190.8 In 2008, the CMA9 reported that in the three territories there were:

- 108 family physicians;
- 12 medical specialists (one anaesthetist, one community medical specialist, one psychiatrist, four internal medicine specialists and five pediatricians); and
- 12 surgical specialists (five general surgeons, one otolaryngologist, four obstetricians/gynaecologists, one ophthalmologist and one orthopaedic surgeon).

9 http://www.cma.ca/multimedia/CMA/Content_Images/Inside_cma/Statistics/01SpecProv.pdf

⁶ Appropriate ambulatory care could have reduced or eliminated the need for hospitalization.

⁷ Information originated in The International Polar Year 2007-2008; The Arctic Human Health Legacy, A.J. Parkinson, Alaska Medicine Supplement

⁸ http://secure.cihi.ca/cihiweb/products/SupDistandMigCanPhysic 2007_e.pdf

CIHI reported¹⁰ that in 2007 there were:

- 64 family physicians, four clinical specialists and four surgical specialists in the Yukon;
- 36 family physicians, seven clinical specialists and six surgical specialists in the Northwest Territories (NT); and
- 8 family physicians and one surgical specialist in Nunavut.

There are no resident radiologists or nuclear medicine physicians in the Yukon or Nunavut where examinations are sent electronically, by courier, or by regular mail to other centres for reading and reporting, and radiologists visit only major centres to perform hands-on examinations on a routine basis. In the Northwest Territories, there are two radiologist positions, both based in Yellowknife.

CIHI recently reported that in 2006, 324 Registered Nurses (RN) and 60 Licensed Practical Nurses (LPN) were employed in the Yukon. The same year 1,033 RN, 92 LPN, and 35 Registered Nurse Practitioners worked in the Northwest Territories and Nunavut combined. Not surprisingly the ratio of physicians and nurses per capita in NWT and NU is far below that of the Yukon, the provinces, or Canada as a whole. Pharmacists, dental care workers, and rehabilitative workers are also scarcer in these two territories. The representations of technical workers and "other" occupations are only marginally less than in other jurisdictions. The Yukon, on the other hand has more workers per capita in all categories, except "technical workers", than in Canada overall. In Canada in 2001 there were 812,000 workers in a health occupation: of those only 12,750 were Aboriginal persons. Of the 400,435 Aboriginal people in the workforce, only 3.0 percent worked in a health occupation.

Methodology

Start up

 Contact each territory's Ministry of Health, hospital/regional administrators, and others as required, in order to introduce the project, clarify any queries and identify key stakeholders to be used for information collection.

Information collection

- The information that was deemed necessary in order to carry out the mandate of the project was identified and templates were developed to aid in date collection
- The templates were distributed. Following collection they were reviewed and any necessary follow up was carried out.

Literature review

 A review of literature on health care delivery in Northern Canada and comparable jurisdictions was carried out in published and online databases.

Statistics

 Sources for population, demographic features, health indicators and other comparative measures were identified and analysed.

Report creation

- The information was collated, analysed and written up into the most comprehensive format possible.
- The information pertaining to each territory was reviewed with the contact persons to ensure that it accurately represented the facts.
- The report was revised and submitted to CRF. Following discussion, minor revisions were made and the final report was submitted.

¹⁰ http://secure.cihi.ca/cihiweb/products/SupDistandMigCanPhysic 2007 e.pdf. Note: these numbers do not agree with those previously quoted or with each territory's annual Canada Health Act Annual Report 2006/07.

Results

The Yukon

The Yukon (YK) is the smallest of the three territories (474,711 square km) and has the second largest population (30,372 in 2006). Some important demographic facts

- The 2006 Canada Census reported that the Yukon's population had increased 5.6 percent from 2001 to 2006;
- From 2006 to 2007 the population continued to grow by 1.2 percent and from 2007 to 2008, by 3.7 percent;¹¹
- Most notably, there has been significant growth in the segment over 55 years of age, in particular from 60 to 65 years of age;
- There has also been significant growth in the portion of the population aged 20 to 29 years; and
- Of the three territories, the Yukon has the smallest percentage of Aboriginal residents (25 percent) and is considered to be the least "rural" (41 percent of the population lives in rural regions).

There are no regional health boards in the Yukon. Two health care insurance plans ensure that eligible residents can access medically necessary physician and hospital services. The performance of diagnostic imaging examinations and interpretation of films are insured under the Yukon Hospital Insurance Services Act.

Whitehorse, the capital of the Yukon is located in the lower southwest corner of the Territory. The Whitehorse General Hospital (WGH), 12,13 the 49-bed hospital operated by the Yukon Hospital Corporation (YHC) is the only acute care hospital facility providing in-patient, outpatient and 24/7 emergency services within the Territory. Inpatient services include: intensive care (3 beds), medicine (21 beds), pediatrics (6 beds), surgery (12 beds), and obstetrics and gynecology (7 beds). Selected rehabilitative therapies are also available on an outpatient basis.

It is understood that the local physicians provide WGH with emergency services on a rotational basis. WGH emergency surgery patients are reported to normally be seen within 24-hours and elective patients, within one to two weeks. WGH surgical services include: some orthopaedics; gynecology; pediatrics; general abdominal; mastectomy; emergency trauma; otolaryngology; and ophthalmology.

In 2007 most of the 57 general/family physicians and all of the nine specialists who were resident in the Yukon, were located in Whitehorse. In addition, the Visiting Specialist Program provides non-resident specialists, whose services are not regularly available in the Territory, with access to WGH. These specialties include medicine, surgery, mental health and dentistry. Visiting specialists' clinics are adjusted to address wait times, especially for orthopedics, otolaryngology and ophthalmology. The WGH diagnostic services include radiology (ultrasound, computed tomography, x-ray and mammography), laboratory, and electro-cardiology.

The Watson Lake Hospital, operated by Yukon Health and Social Services (YHSS), is an acute primary care facility supported by resident physicians. This hospital provides 24/7 emergency response service and primary hospital care services to

¹¹ http://www.eco.gov.yk.ca/stats/pdf/mr_dec08.pdf

¹² Guide to Canadian Healthcare Facilities, 2008, page 407 reports 49 beds at time of printing.

¹³ The information in this section has been taken from the Canada Health Act Annual Report 2005-2006 – Yukon, http://www.hc-sc.gc.ca/hcs-sss/medi-assur/cha-lcs/pt-plans-vk-eng.php. The number of physicians varies from that reported by CMA and CIHI. This may represent normal annual fluctuation.

manage acute pediatric and adult medical conditions; low risk obstetrical deliveries; respite care needs; and palliative care needs. Diagnostic services include basic laboratory testing, electrocardiography and basic radiography. The YHSS also operates 12 rural community health centres where outpatient, 24-hour emergency services, and community health programs are provided by primary health care nurses.

For Health insured hospital services not available locally, patients are transferred to acute care facilities within or outside the Territory through the Travel for Medical Treatment Program. This program covers medically necessary transportation, allowing eligible persons to access insured physician or dental services in locations such as Whitehorse, Vancouver, Edmonton or Calgary. Other insured services provided to eligible Yukon residents include the Chronic Disease and Disability Benefits Program, the Pharmacare and Extended Benefits Programs, and the Children's Drug and Optical Program. The Territory also provides Continuing Care, Community Nursing, Community Health, and Mental Health Services programs.

WGH Diagnostic Imaging Services

WGH provides a significant range of Diagnostic Imaging (DI) services to support the current clinical programs within the Yukon. These DI services include general radiography (x-ray and fluoroscopy), ultrasound, mammography (diagnostic and screening) and CT scan¹⁴.

Patient examinations performed in WGH during the 2007/2008 fiscal year included 12,380 general radiography (x-ray and fluoroscopy) examinations, 3,704 ultrasound procedures, 1,852 mammography (both diagnostic and screening¹⁵) examinations and 2,388 CT scan exams. Reportedly there has been increasing demand for DI services in each modality, particularly for ultrasound; however reasons for this demand are not well understood.

Types of examinations included:

- General radiography
 - o x-ray (fixed unit) chest, skeletal, and other general radiography
 - x-ray (mobiles) general OR procedures (knees, hips and extremities) and ER/trauma, ICU, wards and NICU
 - fluoroscopy BA, Upper GI, SBFT, arthrograms, voiding cystograms, and hysterosalpingograms
- Ultrasound obstetrics/gynaecology, abdomens, pelvis, soft tissue, carotids, breasts, and thyroids
- Mammography diagnostic and screening
- CT scan heads, chest, abdomen, pelvis and spines.

Examinations for nuclear medicine¹⁶, MRI, angiography and cardiac catheterizations are referred outside the territory, often to Edmonton or Vancouver, thus incurring patient transport costs.

The following describes current DI hours of operations, on-call services and wait times at the WGH:

¹⁴ WGH has the only CT, mammography and US facilities in the Yukon. Yukon communities offer limited x-ray services in acute situations only.

¹⁵ WGH estimates that approximately 22% of all mammography examinations are diagnostic and the balance are screening mammograms.

¹⁶ Typically, patients are not "referred" for bone densitometry, but are encouraged to arrange for these examinations when they are making their next trip outside the Territory.

- General radiography services are provided 0800 hours to 2400 hours Monday to Friday, with on-call services the remainder of the time.
- Ultrasound services are provided 0730 hours to 1600 hours on a Monday to Friday basis. There is no on-call coverage outside these hours on weekdays or on weekends. Urgent cases are done the same or next day. Non-urgent cases have an approximate wait time of 20 working days.
- Mammography services are provided from 0800 hours to 1600 hours Monday to Friday. There is a 50 working day wait for screening mammography and a 14 working day wait for diagnostic exams.
- CT scan services are provided from 0730 hours to 1530 hours Monday to Friday with limited on-call coverage for both evenings and weekends. CT oncall service, which is limited to non-contrast examinations of adults, is provided by general duty technologists. CT scans are generally performed the same or next day.

The WGH DI department has 12 technologists¹⁷ (11.0 FTE) distributed amongst the modalities as follows:

- three full time general radiology technologists (3.0 FTE)
- three full time sonographers (3.0 FTE)
- two part time mammography technologists (1.0 FTE)
- two full time CT scan technologists (2.0 FTE)
- one full time PACS administrator (1.0 FTE), and
- one full DI manager (1.0 FTE)

Technologists' shift rotations include: 0700 to 1500 hours, 0800 to 1600 hours, 0900 to 1700 hours and 1600 to 2400 hours (Monday to Friday). There is on-call x-ray service on weekends and during nights (midnight to 0800 hours). While there has occasionally been a need to hire locum technologists for ad hoc coverage such as vacation relief, the department is currently fully staffed and reportedly able to accommodate requests without requiring additional locum techs. If they are needed, locum techs require training in both x-ray and CT in order to provide on-call service.

In addition to the technologists, there are two full time and two casual administrative assistants. Administration of the WGH DI department is independent from that which oversees imaging services in other facilities in the Yukon.

WGH uses Medical Imaging Consultants (MIC), based in Edmonton with 88 radiologist members, to provide services remotely 24/7. MIC also provides onsite coverage two days per month to perform "hands-on" procedures, such as fluoroscopy and certain types of CT and ultrasound. WGH sees MIC's multidisciplinary knowledge and skills in CT, radiography, ultrasound, and mammography as a benefit to meeting their overall requirements. Also, within each modality the MIC consultants possess much needed sub-specialty knowledge, e.g., CT - Neuro, chest, abdomen, and angiography.

In order to support WGH clinical programs and healthcare facilities throughout the Yukon (and to some degree the rest of the Territories) the following imaging technologies are currently in place and are noted in **Table 01** below:

Table 01 – WGH Imaging Equipment

¹⁷ All technologists are cross-trained in x-ray and CT in order to cover call.

Modality	Type	OEM	Model	Year Installed	Archive
Radiographic Unit	Fixed	Siemens	Multix Top	2003/2004	CR > PACS
Radiographic/Fluoroscopic	Fixed	Siemens	Axiom Iconos	2005	CR > PACS
Radiographic Unit	Mobile	Siemens	Siremobile ISO-C	2004	PACS
Radiographic Unit	Mobile	Siemens	Mobilett	2003	CR > PACS
Ultrasound scanner	Fixed	Philips	iU22	2008	PACS
Ultrasound scanner	Fixed	Philips	iU22	2008	PACS
Mammographic Unit	Fixed	Siemens	Inspiration	Jan 2009	FFDM > PACS
CT Scanner	4-slice* CT	Siemens	Somatom Volume Zoom	2003	PACS

^{*} To be upgraded to minimum 64 slice in spring 2009.

The educational allowance, contained within the DI departmental budget on a per FTE basis, allows staff to take advantage of course, convention, and lecture opportunities outside of the Yukon on an annual basis. While at this time it is considered adequate for staff members' needs, it was noted that an increase in the educational allowance for specialized courses will soon be needed.

Central BC and Yukon Telemedicine Initiative

In 2005 a telemedicine project¹⁸ to develop a network and tele-imaging system, initially for specialists centered in Kamloops (Royal Inland Hospital), to view and report promptly on digital imaging was implemented. Images originate from the following health centres:

- Royal Inland Hospital (RIH), Kamloops, British Columbia
- North Shore Radiology, Kamloops, British Columbia
- Chase Health Centre, Chase, British Columbia
- Dr. Helmcken Memorial Hospital, Clearwater, British Columbia
- Barriere Health Centre, Barriere, British Columbia
- Nicola Valley General Hospital, Merritt, British Columbia
- Ashcroft & District General Hospital, Ashcroft, British Columbia
- · Lillooet & District Hospital, Lillooet, British Columbia
- 100 Mile House District General Hospital, 100 Mile House, British Columbia
- Cariboo Memorial Hospital, Williams Lake, British Columbia, and the
- Whitehorse General Hospital, Yukon

The system allows for digital archiving of all imaging modalities and the electronic transfer of these images to referral hospitals or physicians. The project was apparently completed on time and within budget and is reported to be very successful in furthering patient care in all areas that the system encompasses.

Problems¹⁹ encountered and resolved during implementation included Yukon's need for two-way interfaces between the PACS and the RIS, that being the Fujifilm's "Synapse" PACS and Meditech's RAD RIS module. Synapse used a "brokerless" interface, but issues arose primarily concerning the definition of common data base "keys', matching field sizes, and determining their configuration. Once these issues were resolved, the interface was reported to work very reliably.

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¹⁸ Central BC and Yukon telemedicine initiative, http://www.hc-sc.gc.ca/hcs-sss/pubs/chipp-ppics/2003-bcb-yk-tele/bcbyktele_intro-eng.php

⁹ Ibid

In addition, the Yukon had concerns about the reliability of accessing its data over the Virtual Private Network (VPN). Initially all of the Yukon's data was to be stored on the Storage Area Network (SAN) at Royal Inland Hospital, Kamloops. Following a risk assessment, the Yukon decided that although the risk was not excessive, they needed a more reliable system. As a result a SAN of their own was purchased, which provides local storage, with the Kamloops SAN being used for archival use and backup as needed. This addition to the overall system has reportedly proved to work extremely well.

WGH has since moved its contract for "reading" and reporting exams to MIC in Edmonton. Now, the WGH DI Department relies upon teleradiology for approximately 90% of its viewing and reporting. In the future, this system will be rolled out to all other health facilities that provide imaging services in the Territory.

Watson Lake Hospital and Community Health Centres

Since 1997, Community Nursing has been responsible for basic x-ray programs at Watson Lake Hospital and the health centres. All health facilities outside WGH with the exception of Beaver Creek Health Centre and Destruction Bay Health Centre have the ability to provide x-rays of the chest and extremities. Neither ultrasound nor fluoroscopy is provided outside of WGH due to insufficient work load volumes, and perceived difficulties in maintaining trained staff and quality of service. Therefore, community patients requiring ultrasound or fluoroscopy (and other imaging services performed at WGH) are transported to WGH while those requiring services not available at WGH are sent to Vancouver. ²¹

Occasionally when managing a patient requiring emergency care, a physician may order x-rays of the head and spine, primarily as an adjunct for making treatment decisions and determining any special transportation considerations. In some cases, patient condition (requiring more complex examinations) or patient size (mobile x-ray machine not powerful enough for large patients) may dictate the need to transport the patient to WGH. When circumstances dictate a need, "digital pictures of x-rays are sent to ER doctors in WGH to assist with management or triage decisions"²²; thereby acting as a substitute for a PACS. It was reported that when orthopaedic surgeons go to Whitehorse they request that all views be performed at WGH thus requiring that patients make an additional trip to Whitehorse prior to their specialist appointments.

During the 2007/08 fiscal year, 2994 x-rays were performed at Watson Lake Hospital and the ten community sites. Of these, 1320 were chest x-rays, 1521 were extremity x-rays and 153 were other examinations such as cervical and lumbar spine, skull, facial bone, and abdomen x-rays: the latter group often being performed by the ordering physicians. The annual increase in examination volumes seems to be related to increased demand for screening for employment purposes and an increase in the number of tuberculosis (TB) outbreaks. It is further noted that only the 14" x 17" film size is used in the community health centres. All community health centre films are sent to Vancouver for interpretation, report transcription and an assessment of examination quality.

To accommodate chest and extremity x-rays each community health centre has mobile x-ray capabilities through the use of a DynaRad HF-110A mobile x-ray machine. Watson Lake Hospital has a Sedecal high frequency portable x-ray unit to

22 http://www.hss.gov.yk.ca/programs/nursing/ytn/

15

²⁰ Mobile x-ray units were being installed in these health centres while this project took place.

Note: this may change and they may be sent to Edmonton as soon as the RIS/PACS is operational.

better support its more extensive patient medical imaging requirements. Watson Lake Hospital and three of the community health centre facilities capable of providing x-ray services have automatic film processors, while the balance still develop their film by hand (see **Table 02**).

Table 02: Imaging Equipment in Watson Lake Hospital and the Health Centres

Town/City	Site Name	X-ray	OEM	Model	Yr	Processing
Beaver Creek	Beaver Creek Health Centre	no-next year				
Carcross	Carcross Health Centre	portable	DynaRad	HF-110A	2001	hand developed
Carmacks	Carmacks Health Centre	portable	DynaRad	HF-110A	2005	hand developed
Dawson City	Dawson City Health Centre	portable	DynaRad	HF-110A	2002	auto processing
Destruction Bay	Destruction Bay Health Centre	no-next year				
Faro	Faro Nursing Station	portable	DynaRad	HF-110A	2001	hand developed
Haines Junction	Haines Junction Health Centre	portable	DynaRad	HF-110A	2000	auto processing
Mayo	Mayo Nursing Station	portable	DynaRad	HF-110A	1999	auto processing
Old Crow	Old Crow Nursing Home	portable	DynaRad	HF-110A	2005	hand developed
Pelly Crossing	Pelly Crossing Health Centre	portable	DynaRad	HF-110A	2001	hand developed
Ross River	Ross River Health Centre	portable	DynaRad	HF-110A	1999	hand developed
Teslin	Teslin Health Centre	portable	DynaRad	HF-110A	1999	hand developed
Watson Lake	Watson Lake Hospital	portable	Sedecal		2005	auto processing

Nurses at the Watson Lake Hospital and at each health centre with x-ray service capabilities are trained to do chest and extremity x-rays, unlike health centres in the Northwest Territories where non-nursing staff also perform basic x-rays as they are seen to have a more consistent and stable onsite presence i.e., they perform less shift work.

Community health centre representatives noted that the WGH Diagnostic Imaging Department has been very good at training community health centre staff. The WGH department provides a four-hour course to assigned community nurses on how to position for chest and limbs, as well as some guidance on the Quality Assurance (QA) process and radiation protection. Periodically they provide a refresher when needed. The nurses do not have any form of certificate or other formal training related to diagnostic imaging

Currently, the Yukon is working with Canada Health Infoway (CHI) on a PACS initiative which will be implemented in 2009. As part of this initiative mobile x-ray units will be installed in Beaver Creek Health Centre and Destruction Bay Health Centre. The mobile x-ray machines, at all sites, used in combination with CR technology will then allow all x-ray examinations to be produced in a digital format and the information to be archived electronically. The exam information can then be shared through existing and enhanced telehealth capabilities that are planned for the future.

All images will be sent to WGH in order to centralize the data and then they will be forwarded to Edmonton for review and reporting. Part of this plan will be to set-up CR in darkroom areas or other available spaces. In addition, the use of a digitizer to archive previous films on an "as needed only" basis is planned.

Installation of CR technology is hoped to resolve a number of issues related to quality and efficiency, such as:

- Hand developing which causes delay of service will be eliminated
- Previous "darkroom disease issues" will be avoided
- Shipping and temperature issues (frozen chemistry) will be eliminated
- · Film/static issues will be eliminated
- 14X17 film size use only will be eliminated
- Written reports within 48 hours (faxed), but film shipment seven to ten days will be avoided and as a result, patient care will be improved
- 30 years of film archive at each health centre will slowly be eliminated and the space can be used for other purposes
- Darkroom space can be reused
- Expensive patient transport costs are hoped to be reduced
- PACS/teleradiology is seen to improve response time

Reported Status of Service Delivery

The WGH DI department performs daily, weekly, monthly and quarterly assessments of quality. As well, there are two scheduled Preventative Maintenance routines performed by the vendors of all their equipment each year.

Through communication with the DI contacts it was learned that recruitment and retention of qualified technologists is an issue that requires ongoing attention. At WGH, having up to date technology in the modalities that they provide is viewed as one of their strengths, and undoubtedly serves as a motivator to attract staff. Currently, they are fully staffed and have no need for even locum coverage.

Community sites report that they have a monthly quality assurance assessment of their processes including quality of radiation techniques, manual processing factors, film density quality, and equipment maintenance (including corrective actions). In line with their Preventative Maintenance Contract a visiting technologist audits the darkroom and film processing procedures, the x-ray room and accessory equipment, the x-ray unit, and provides any technical or positioning guidance required by staff. The manager, during routine site visits, audits for adherence to protocols, processes, business flow, and general functionality of equipment. The sites are now in the process of documenting the competencies associated with taking x-rays in the rural treatment setting to ensure that examinations are performed safely and correctly.

Although there are difficulties associated with maintaining DI services in community health centres, e.g., maintaining competency levels, the benefits to patients are perceived to far outweigh any negatives. Having imaging services available:

- provides immediate access to DI when emergency management of a patient is required, e.g., being able to identify the degree of a fracture to determine immediate care requirements and to assist in deciding when a patient might need to travel to Whitehorse for an advanced level of care;
- allows for ongoing surveillance for management of a specific disease or condition such as TB, pneumonia, or the post-fracture recovery process;
- provides community access for basic DI when required for pre-employment or immigration purposes;
- reduces the need for unnecessary travel and reduces associated costs; and

 provides expanded role nurses (primary health care nurses) with the tools to provide better care.

The Yukon, along with Nunavut and the Northwest Territories has two territorial representatives, at the national level, on the Federal Provincial Territorial Radiation Protection Committee (FPTRPC). This group works to advance the development and coordination of practices and standards for radiation protection, federally and within the provinces and territories, and to communicate these to the people of Canada. The committee's role has particular value in jurisdictions such as the territories where resources for radiation protection are limited or virtually inexistent.

Several areas were noted as being possible areas for collaboration:

- Assistance with development of competencies for rural and remote settings
- Development of web-based training components that can be used in conjunction with on-site instruction.

The Northwest Territories

The Northwest Territories (NT) is significantly larger than the Yukon, covering 1,140,835 square kilometres, and it has the largest population of the three territories (41,464 in 2006 according to Statistics Canada). Some important demographic features include:

- The population increased 5.9 percent from 2001 to 2006²³ and it has grown by less than one percent since then;
- The most significant population growth has taken place in the segment over 50 years of age, in particular from 60 years upward;
- The Territory has a young population and high birth rate: approximately 25 percent of the population was under 25 in 2006 compared to 17 percent in Canada overall; and
- Approximately 50 percent of the Territory's residents report having an Aboriginal identity and 42 percent of the population are classified as living in a rural area, very similar to the Yukon.

Within the Territory, seven Health and Social Service Authorities plus the Tlicho Community Services Agency are responsible for the delivery of health care services. The Department of Health and Social Services pays for all inpatient and outpatient diagnostic imaging examinations and reading of films whether performed by radiologists in Yellowknife or provinces to the south, as these services are insured under the Territory's Hospital Insurance Plan.

Yellowknife, the capital of the Northwest Territories is home to the 88-bed Stanton Territorial Hospital²⁴ (STH), the largest and most comprehensive acute care facility in the Territory. STH provides emergency services as well as intensive care, obstetrics, pediatrics, medicine, surgery, and psychiatry inpatient services. Patients are diagnosed and treated on a "day care" basis in the Dialysis Unit, the Rehabilitation Unit, the Medical Day Care Unit and the Surgical Day Care Unit. In addition there are a number of specialist clinics associated with STH. Satellite Mental Health and Ophthalmology Clinics are located in downtown Yellowknife. An Extended Care Unit provides care to elderly and disabled patients (including dementia patients) and also provides palliative/respite care. STH diagnostic services include radiology (ultrasound, computed tomography, x-ray, bone densitometry, and mammography), laboratory, and electro-cardiology.

In 2007 most of the 36 general/family physicians and the 13 specialists who were resident in the NT were located in Yellowknife. The Northwest Territories has a close working relationship with medical specialists in Alberta, especially Edmonton, and a number of these specialists visit to provide medical and surgical services not available locally. These services include: Urology; Gynecological Urology; Obstetrical Oncology; Neurology/Orthopedic Back Care; Pediatric Cardiology, Orthopedics, and Allergy; Rheumatology; Neurology; Adult Cardiology; General Oncology; Nephrology; and online Dermatology. Specialist physicians and rehabilitation staff from STH also travel to a number of larger centres in the NT and Nunavut to provide residents of smaller communities with access to a wider range of health care services. It is necessary to refer out of the Territory for tertiary and highly specialized services (e.g., vascular surgery and neurosurgery) that cannot be sustained within the NT.

²⁴ http://www.stha.ca/files/services/100/2006-07%20annual%20report.pdf?PHPSESSID=252790041a862f0787978ca3fee88773

²³ Information in this paragraph from http://stats.gov.nt.ca and 2006 Statistics Canada

There are three other hospitals in the Northwest Territories:

- The Inuvik Regional Hospital (IRH) in the Beaufort-Delta region. This 51-bed acute care hospital provides 24/7 emergency services; obstetrical care; medical and surgical (limited) inpatient care; Long Term Care and a variety of hospital-based family medicine clinics and visiting specialist clinics. Its diagnostic services include medical imaging (x-ray, ultrasound and mammography), laboratory services, and electro-cardiology.
- The H.H. Williams Memorial Hospital (HHWMH) in Hay River. This 50-bed general hospital's services include acute care (surgical and medical), a Dialysis Unit, detoxification beds, Home Care (including palliative care and rehabilitative care), Extended Care, and a medical clinic. Diagnostic imaging services include x-ray, ultrasound, and mammography.
- The Fort Smith Health Centre. This facility focuses upon outpatient care and offers physician clinics: it also has 12 acute care beds (no surgical services) and 13 long term care beds. Diagnostic services include laboratory and medical imaging (x-ray and ultrasound).

Insured medical services are delivered on an outpatient basis in the 28 community health centres throughout the Territory. Twenty of these centres provide basic x-ray services.

Where medically necessary services are not available in the Territory, residents travel to hospitals or clinics in other jurisdictions. The Territory offers a Medical Travel Assistance program to ensure that residents have no barriers to accessing these services.

DI Services at the Stanton Territorial Hospital

STH provides a comprehensive range of DI services to support clinical programs within the Territory. These DI services include general radiography (x-ray and fluoroscopy), ultrasound, mammography (diagnostic and screening), bone densitometry, and CT scan.

Patient examinations performed in STH during the 2007/2008 fiscal year included 21,436 general radiography (x-ray and fluoroscopy) examinations, 7,075 ultrasound procedures, 1,153 diagnostic mammograms, 363 bone densitometry examinations, and 3,507 CT scan exams. It was reported that over the past three years demand has increased for services in each modality, particularly for CT scans and ultrasound.

Types of examinations include:

- General radiography
 - o x-ray (fixed unit) chest, skeletal, trauma, and other general radiography
 - o x-ray (mobiles) general OR procedures (knees, hips and extremities) and when needed, in-patient units throughout the hospital
 - fluoroscopy BA, Upper GI, SBFT, arthrograms, voiding cystograms, and hysterosalpingograms
- Ultrasound (both mobile)- obstetrics/gynaecology, abdomen, pelvic, soft tissue, breasts, thyroid, ER and wards when needed
- Mammography diagnostic and screening
- CT scan skeletal, muscle, soft tissue and blood vessels
- Bone densitometry lumbar spine, hip, forearms.

When an interventional radiologist is onsite, procedures such as aspirations, biopsies, and drainages are performed using ultrasound, CT or radiography/fluoroscopy. The interventionalist is booked based upon demand; however as soon as local physicians become aware that interventional services are going to be made available, many more patients are referred.

Patients requiring nuclear medicine examinations (other than bone densitometry), MRI scans, angiography, and cardiac catheterizations are referred outside the Territory with the vast majority traveling to Edmonton as elective or emergency patients. Elective patients be seen in an Edmonton hospital or may choose to go to a clinic. Patients' travel and medical costs are covered by the Medical Travel Assistance program.

The STH provides DI services and on call services as follows:

- General radiography services are provided 0730 to 1700 hours Monday to Friday and 0800 to 1600 hours on weekends, with on-call service outside these hours.
- Ultrasound services are provided 0800 to 1630 hours Monday to Friday.
 There is no on-call coverage after-hours weekdays or on weekends. Wait times are approximately eight weeks.
- Mammography services are provided only from 0800 to 1600 hours Monday to Friday.
- Bone densitometry examinations are performed only from 0800 to 1200 hours, three days per week. Currently coverage in this modality is very limited due to a staff vacancy, and as a result more than 30 patients are waiting to be seen.
- CT scan services are provided from 0730 to 1530 hours Monday to Friday with on-call coverage during evenings and weekends. Wait times are approximately three to four weeks.

The STH provides all diagnostic and screening mammography services for Yellowknife residents. Residents outside Yellowknife are not included within the screening program, necessitating that when they are seen at STH for screening mammograms their exams are performed as diagnostic mammograms. Patients requiring breast biopsies are referred to Edmonton for these procedures.

The STH DI department has 10 technologists (9.5 FTE) distributed amongst the modalities as follows:

- Four general radiology technologists (4.0 FTE)
- Three sonographers (2.5 FTE)
- One mammography technologist (1.0 FTE)
- One full time CT scan technologist (1.0 FTE)
- One full time PACS administrator (1.0 FTE), and
- One technologist supervisor position which is vacant²⁵.

The general radiography technologists rotate throughout the weekends. Locum technologists are hired for ad hoc coverage such as vacation relief, often coming from Eastern Canada. When locums are needed for ultrasound, it is desirable that they have echo-cardiology experience in order to provide full coverage. In addition to the technologists, there is a booking clerk, a dicta-typist, and four other clerks who provide reception, film library and other office services.

²⁵ The previous technologist supervisor, who was responsible for all DI services in the Territory, was seconded to the PACS administrator position, leaving a vacancy. Currently, all DI services are administered through the Territory's Manager of Diagnostic and Therapeutic Services.

During times when one or both of the STH radiologist positions are vacant, such as now, the positions are filled on a one to three week locum basis. Locums typically originate from Nova Scotia, Quebec, Ontario, Alberta or British Columbia. The radiologists generally work 8-hour days with one of them covering evenings and weekends. Unfortunately when locums are covering, it is not uncommon to be without radiologist service on weekends because both radiologists are traveling to or from their homes. The STH DI Department reports that it is not always able to hire locum radiologists who can read and report CT scans and mammograms and that very few locums have interventional radiography expertise. Films from other hospitals in the Territory and from the community health centres are sent to the STH radiologists for interpretation and reporting. Films from the Kitikmeot region of Nunavut are also sent to STH and will be reviewed when discussing Nunavut.

When radiologists are not onsite or when they do not have the specific skills to read certain types of examinations, the films are sent outside the Territory for interpretation and reporting. In 2007/08, 3,265 general radiology films, 168 ultrasound examinations, 584 CT scans and 28 bone density examinations were couriered to Calgary for reading and reporting. The films are couriered by plane; however when they arrive in Calgary, they are transferred by a third party which incurs considerable time and which, in turn, delays the turnaround time beyond an acceptable limit. The same year, 507 diagnostic mammograms and all screening mammograms were sent to Edmonton for reporting.

To support the STH clinical programs and healthcare facilities throughout the Northwest Territories (and to some degree Nunavut) the imaging technologies noted in **Table 03** below²⁶ are currently in place:

Table 03 - The STH Imaging Equipment

Modality	Type	OEM	Model	Year Installed	Archive
Radiographic Unit	Fixed	Toshiba		2005	Hardcopy Film
Radiographic/Fluor oscopic	Fixed	Toshiba	Ultimax	2005	Hardcopy Film
Radiographic Unit	Fixed	Toshiba		2005	Hardcopy Film
Radiographic Unit	Mobile	Toshiba		2005	Hardcopy Film
Radiographic Unit	Mobile	Toshiba	Aplio 80	2005	Hardcopy Film
Ultrasound scanner	Mobile	Toshiba	Aplio 80	2005	Hardcopy Film
Ultrasound scanner	Mobile	Toshiba	iU22	2005	Hardcopy Film
Mammographic Unit	Fixed	GE	Senographe DMR	1996	Hardcopy Film
CT scanner	Fixed	Toshiba	Aquillion 16	2005	Mod/CD Hardcopy
Bone densitometer	Fixed	GE	Lunar Prodigy	2006	Paper Softcopy

²⁶ A PACS was to be implemented at the STH in early March, followed by the hospitals in Fort Smith, Hay River and Inuvik in April 2009.

DI technologists are provided an annual professional development allowance of \$2000 each. There are not enough technologists in Canada's North to be able to afford to pay speakers to come to them, so they are reliant upon travel to other locations to meet their educational needs. It was noted that because this allowance must cover travel, accommodation and course or conference costs, the technologists often have to supplement their educational expenses.

DI Services in Other NT Hospitals

X-ray and ultrasound services are provided by all three hospitals and mammography services are also provided in the hospitals in Hay River and Inuvik. In common with the STH DI department, imaging services in these three hospitals are administered through the Territory's Manager of Diagnostic and Therapeutic Services. **Table 04** shows the number of examinations performed in 2007/08 and where the films were read and reported. Normally all x-ray and ultrasound examinations are couriered to STH for interpretation, but when there is only one radiologist covering at STH the other hospitals send their examinations to Alberta.

Table 04: DI examinations 2007/08

	140000000000000000000000000000000000000							
Modality	Inuvik Regional		H. H. Williams		Fort Smith Health			
	Hospital		Memoria	Memorial Hospital		ntre		
	Exams	Reported	Exams	Reported	Exams	Reported		
X-ray	3,862	STH	2,960	STH and Calgary	866	STH		
Ultrasound	1,363	STH	977	STH and Calgary	185	STH		
Mammography	381	Edmonton	*	Edmonton	N/A	N/A		

^{*} Service began in fall 2008

In all three hospitals the types of DI examinations include:

- General radiography
 - o x-ray (fixed unit) chest, skeletal, trauma, and other general radiography
 - o x-ray (mobiles) trauma and emergency
- Ultrasound (both mobile) obstetrics/gynaecology, abdomen, pelvic, soft tissue, breasts, thyroid, ER and wards when needed
- Mammography screening only (none at Fort Smith)

Patients who require other diagnostic imaging studies available in Yellowknife are referred to STH and their costs are covered under the Travel Medical Assistance Program, while those requiring more specialized diagnostic imaging services are referred to Alberta, with most going to Edmonton as emergency or elective patients.

All three hospitals provide x-ray services from 0800 to 1600 hours Monday to Friday and on-call service the remainder of the week. At the Inuvik Regional Hospital ultrasound services are provided during the same hours as x-ray services, and mammography screening clinics take place anywhere from two to five times annually, based upon demand and locum availability. The H.H. Williams Memorial Hospital provides ultrasound services only when a technologist is available and mammography screening services on an ad hoc basis, depending upon demand. The Fort Smith Health Centre is able to provide ultrasound services only when a sonographer is available.

When fully staffed, the Inuvik Regional Hospital has three technologist FTE. Currently they have only one technologist who has to provide service 24/7 when locums are not available to assist. As this facility provides both general radiography and

ultrasound services it requires technologists who are trained in both, a particularly difficult combination to recruit. When there is sufficient demand for a minimum of one week of mammography screening examinations, then the hospital arranges for a locum from outside the Territory or a volunteer from within the Territory to assist.

The H.H. Williams Memorial Hospital also has three FTE technologist positions. One of these is filled by a lab/x-ray technologist (CLXT); another is filled by a technologist (mammography and ultrasound) who wishes to semi-retire and reduce her hours to 0.5 FTE; and the final position is a supervisor position which has been vacant for more than one year. The Fort Smith Health Centre has three CLXT positions. Technologists from the STH travel to Fort Smith on their days off or on weekends to perform ultrasound examinations.

Table 05 shows the DI equipment in each of these hospitals. Reportedly, the ultrasound unit at the Inuvik Regional Hospital is in need of replacement.

Table 05: DI Equipment in NT Hospitals

Location	Modality	Туре	OEM	Model	Year Installed	Archive
IRH	Radiographic/Fl uoroscopy Unit	Fixed	Toshiba		GenRad 2005 Fluoro 1995	Hardcopy Film
IRH	Radiographic Unit	Mobile	Toshiba		2005	Hardcopy Film
IRH	Radiographic Unit	Mobile	Philips	AMX4	1995	Hardcopy Film
ннммн	Radiographic Unit	Fixed	Toshiba		2005	Hardcopy Film
ннммн	Radiographic Unit	Mobile	Toshiba		2005	Hardcopy Film
ннммн	Radiographic Unit	Mobile	Siemens		> 12 years	Hardcopy Film
FSHC	Radiographic Unit	Fixed	Toshiba		2003	Hardcopy Film
FSHC	Radiographic Unit	Mobile	Toshiba		2005	Hardcopy Film
IRH	Ultrasound scanner	Mobile	Philips ATL	HDI 5000	2001	Hardcopy Film
ннwмн	Ultrasound scanner	Mobile	Sonosite		2003	Hardcopy Film
ннwмн	Ultrasound scanner	Mobile	Aloka		> 8 years	Hardcopy Film
FSHC	Ultrasound scanner	Mobile	GE		2005	Hardcopy Film
IRH	Mammography Unit	Fixed	GE	Senographe 800T	1999	Hardcopy Film
ннммн	Mammography Unit	Fixed	Planned	Sophie	2008	CR and Hardcopy Film

Imaging in Community Health Centres

Of the 28 community health centres in the Territory, 20 provide basic imaging services²⁷, limited to x-rays of chests and extremities. Ultrasound, fluoroscopy and mammography services are available only at the four hospitals, while CT and bone densitometry are available only in Yellowknife. Rural community patients who require these services are referred to the facility closest to them and those who require services not available in the Territory are referred to Alberta with financial assistance through the Travel Medical Assistance Program.

In the fiscal year 2007/2008, 3785 x-rays were performed in the 20 centres. Appendix 1 identifies the number of examinations performed by individual health centres. Over the past few years there is reported to have been a modest increase in the number of x-rays performed in these sites.

Films produced in the community health centres are sent by regular mail to Yellowknife for interpretation and reporting. Although in most communities regular mail travels by air, limited plane schedules may delay mail delivery up to one week. Nonetheless the postal service is preferable to other methods of transport which have been tried, as it has been found to be more reliable.

In community health centres, nurses and janitorial staff are authorized to perform x-rays of chest and extremities only. In rare cases ordering physicians may perform x-rays of other body parts. In the past, the nurses and housekeeping staff received training from STH technologists, but this has become difficult to sustain due to the shortage of technologists, especially considering that the community health centres experience a high turnover of their nursing staff. The training program used to include guidance on positioning, processing and radiation protection.²⁸ It now takes place only on an ad hoc basis through Aurora College.

In order to accommodate their imaging needs, 19 of the health centres have a DynaRad HF-110 mobile x-ray unit, nearly all of which were purchased in 2005. In these centres, films are automatically processed. The Fort Simpson Health and Social Services Centre also has a Gemdex general radiography unit which has been in place for at least 18 years. The Wekweti Community Wellness Centre borrows a mobile x-ray from the STH during outbreaks of flu or TB (performed only 34 exams in 2007/08). Appendix 1 lists the various health centres, their imaging equipment, and examination volumes. It was noted that a number of facilities do not have any form of x-ray table; consequently they are using makeshift alternatives.

Telemedicine

In 2002, the Medipatient RIS was installed in each of the four hospitals. Currently STH uses this system to register patients and store reports whereas the other three hospitals only register patients in the RIS, but they are working towards storing their reports in the RIS so that all images can be shared amongst facilities. With the impending arrival of the EHR and PACS it is imperative that this effort be completed in the near future.

At the present time, all images are produced in hardcopy film and if they need to be transferred between sites, they are physically mailed or couriered. The Agfa Impax 6 PACS is being installed with an expected "go live" date of March 3, 2009 at the STH,

²⁷ They are also administered through the Territory's Manager of Diagnostic and Therapeutic Services. ²⁸ It is of interest that one goal of the NT Integrated Service Delivery Modal is to increase the number of "certified lay radiology workers", reported on page 27 at:

 $http://www.hlthss.gov.nt.ca/pdf/reports/health_care_system/2004/english/isdm/isdm_a_detailed_description.pdf$

and the end of April 2009 at the other three hospitals. The community health centres will be obtaining CR units which will allow them to collect and store images in digital format and transmit them electronically to the STH PACS for interpretation and reporting. General radiography, ultrasound, CT, bone densitometry and echocardiology examinations will all be collected, stored, displayed, distributed and managed in this system. As the PACS system will eliminate the need to send films between sites, it is expected to reduce the turnaround time between imaging examination and report, and provide patients with much better quality of care.

The teleradiology system that was installed some time ago to allow the four hospitals to share images is reported to have never been fully utilized and used to its full advantage. On a recent occasion though, when radiologist coverage in Yellowknife was nonexistent, this system was successfully used to send 500 general radiography, ultrasound, and CT examinations to an external source for interpretation and reporting over a 2-week period. The expectation is that combined with the new PACS, teleradiology might serve the Territory well when there is not a full complement of radiologists at the STH, e.g., over weekends when both radiologists are often travelling to or from their homes.

Reported Status of Service Delivery

At STH, wait times for all modalities are very good and all urgent examinations except bone densitometry can be performed within 24 hours. The 30 person wait for bone densitometry studies has accumulated due to limited coverage arising from the current staff shortage. The STH Department reports that patients are waiting three to four weeks for CT scans and approximately 8 weeks for ultrasound studies, both of which are close to their established benchmarks.

Recruitment and retention of qualified staff, both physicians and technologists, is reported to be an ongoing concern that can have huge impact upon the delivery of imaging services in the four hospitals. When the health facilities lack staff it may not be possible to perform the exams in the Territory and patients may have to be sent south for their imaging examinations. Similarly when radiologists are not available to read examinations then the films may need to be sent to Alberta to be reported, with consequent waits for test results that, in turn, can have negative impact upon patient care.

The lack of a regular and ongoing training program for nurses and members of housekeeping staff who perform x-rays in community health centres, could contribute to less than optimal quality and consistency of images. Ideally there needs to be more focus and effort put into an initial training program and refresher courses. This becomes a difficult task for the STH Department during times when it is not fully staffed and must make patient care within its own facility the top priority.

The STH DI Department is reported to be seen as friendly, efficient, and providing good reports and advice. Staff members are reported to take pride in their department. The lack of space is a concern, along with the lack of ease of access to interventional and screening services. It was reported that there is a need to plan for the future: to determine what services will be needed and the consequent need for staffing, space, equipment and funding.

The arrival of PACS and better use of teleradiology should be able to provide faster turnaround times for all imaging examinations in the Territory and as a result, improve patient care. The RIS/PACS may also help with some aspects of quality

assurance and with teaching. Teleradiology could serve to supplement radiologist coverage in Yellowknife when onsite service is understaffed.

There is a stated need for an ongoing imaging and radiation protection quality assurance program throughout the Territory to monitor aspects of service delivery such as wait times, repeat rates etc. There is no radiation protection officer, a position which could be shared amongst the three territories.

Nunavut

Nunavut (NU) covers 1,932,255 square kilometres²⁹, almost one-fifth the land mass of Canada, and its population was reported to be 29,474 in 2006. Some important demographic features include:

- Nunavut's population grew by 10.2 percent between 2001 and 2006;
- The population continued to grow at a rate of 2.3 percent from 2006 to 2007 and 1.3 percent from 2007 to 2008;
- There has been remarkable growth in the segment of Nunavut's population aged 60 years or more, in particular the group aged 60 to 64 years, which increased 15.8 percent from 2006 to 2007 alone;
- Nunavut's residents are very young: in 2006 Statistics Canada reported that Nunavut's median age was 23.1 years compared to Canada's median age of 39.5 years;
- This Territory is the most "rural" region in Canada, with more than 68 percent of its people living in remote areas;
- Nearly 85 percent of Nunavut's residents report having an Aboriginal identity;
 and
- The workforce is highly transient, with skilled labourers and seasonal workers travelling to the Territory from other provinces and territories.

Nunavut has three regions: the Baffin with 11 communities; the Kivalliq with eight communities; and the Kitikmeot with five communities. Up until 1999, when the management and delivery of health services was integrated into the Department of Health and Social Services, each of these regions had its own health board³⁰. The Department now has a regional office in each of the old regions. Performance and interpretation of inpatient and outpatient diagnostic imaging services are insured services under the Nunavut Hospital Insurance and Health and Social Services Administration Act.

The Territory's only regional hospital is located in Iqaluit, the capital city of Nunavut, on Baffin Island. The Qikiqtani General Hospital (QGH)³¹, completed in late 2007 to replace the Baffin Regional Hospital, serves local residents and patients brought in from smaller Baffin communities. It was built with a capacity of 35 beds, but as of 2006/07 it was not yet operating to capacity, with 26 adult and pediatric beds available for acute, rehabilitative, palliative and chronic care services. QGH was expected to begin to operate at full capacity in 2007/08. The new facility also has an emergency room, an operating room, a treatment room for minor procedures, diagnostic services such as medical imaging and a laboratory, and a host of family physicians and specialists. Medical services include an ambulatory care clinic, limited intensive care services, general medical care, maternity, and palliative care. Surgical services include minor orthopaedics, gynaecology, pediatrics, general abdominal, emergency trauma, and otolaryngology. Baffin region patients with more specialized needs are referred to Ottawa.

Approximately nine doctors are resident in the Baffin region (each physician is assigned to a community and their assignments may vary), including one surgeon and an anaesthetist at the QGH. In addition, there are two physicians in the Kivalliq

²⁹ Statistics in this paragraph come from http://www.gov.nu.ca/eia/stats/ and http://www12.statcan.ca/english/profil01/CP01/Details/Page.cfm?Lang=E&Geo1=PR&Code1=62&Geo2=PR&Code2=01&Data=Count&SearchText=nunavut&SearchType=Begins&SearchPR=01&B1=All&Custom=

³⁰ As reported by Nunavut contacts: however the Canada Health Act Annual report reports that this transition took place on March 31 2000.

³¹ Information in this section originated in http://www.gov.nu.ca/news/2007/oct/oct/9fe.pdf

region and one in the Kitikmeot region. Funding exists for 18 full time positions³² across the Territory but recruiting physicians for such remote areas is an ongoing and onerous task.

The pre-existing Baffin Regional Hospital now houses dietetics, pharmacy, the outpatient department, environmental and support services, and numerous family physician and specialist clinics. In addition to resident physicians, the Territory accesses specialist services from health centres in Ottawa, Winnipeg, Yellowknife and Edmonton. Week long clinics at QGH include, amongst other specialties: cardiology, orthopaedics, otolaryngology, obstetrics and gynaecology, internal medicine, urology, and ophthalmology. Some specialties offer separate pediatric and adult clinics. There are also standing optical and dental clinics. In 2007, a total of 127 physicians participated in the health insurance plan, in resident or visiting capacities.

An additional 26 new positions were created to operate the expanded hospital, thereby increasing the number of nurses, medical radiation technologists, clerk interpreters and housekeeping staff.

Two family physicians and three nurse practitioners staff a family practice clinic in Iqaluit which operates on a community-based health services delivery model. This clinic has been successful in reducing pressure on the emergency and outpatient departments of the Qikiqtani General Hospital.

Relatively new regional facilities in Rankin Inlet and Cambridge Bay were constructed with capacity for 9 inpatient beds; however they are currently limited to providing outpatient care. Rankin Inlet also has a small number of birthing beds. The regional facilities are currently in the developmental phase, their goal being to build a physician base in order to offer a broader range of outpatient, as well as inpatient, services to their communities. In the long term, increased internal capacity will allow the Territory to sustain an enhanced range of services. Kivalliq patients who require more specialized care than Rankin Inlet is able to provide are flown to Churchill or, if necessary, straight to Winnipeg. Kitikmeot Bay patients who cannot be treated at Cambridge Bay are flown to Yellowknife.

Twenty-two communities across Nunavut have local health centres which provide public health, outpatient, and 24-hour emergency nursing services. These centres are staffed by nurses equipped to manage minor emergencies and illnesses. They operate during regular hours on weekdays and provide on-call services otherwise.

More than one quarter of the Nunavut Health Department's operational budget is spent on costs associated with medical travel and treatment provided in extraterritorial facilities. Where insured medical services are available within a region of Nunavut, patients are referred intra-region: where they are not, patients are referred to the closest centre outside the Territory. Nunavut has health service agreements in place with medical and treatment centres in Ottawa, Winnipeg, Yellowknife and Edmonton. The Non-Insured Health Benefits (NIHB) Program covers a co-payment for Inuit and First Nations residents who need medical travel, accommodations and meals at boarding homes (Ottawa, Churchill, Winnipeg, Edmonton and Yellowknife), prescription drugs, dental treatment, vision care, medical supplies and prostheses,

³² These are in addition to the QGH surgeon and anaesthetist.

³³ At this point in time they have no blood products and are less equipped than Iqaluit to handle emergencies.

and other incidental services. The Nunavut Health and Social Services Department administers funds for this program on behalf of Health Canada.

Diagnostic Imaging Services in the Qikiqtani General Hospital

QGH provides diagnostic imaging services to support the clinical programs in its region: these DI services include: general radiography (x-ray and fluoroscopy), diagnostic mammography, and ultrasound. Once every three months a radiologist from Diagnostic Imaging Consultants in Ottawa travels to Iqaluit and performs special examinations such as barium and upper GI studies. The radiologist also reads all films produced during his stay and assists the technologists with any backlog of ultrasound studies. Due to the lack of a breast screening program, women are encouraged to have screening mammograms when they travel to other territories or to the provinces; however there is no coverage for these examinations. No interventional radiographic procedures are carried out in the Territory.

In 2007/08, QGH performed 3527 general x-rays examinations, 39 fluoroscopic examinations, 1551 ultrasound studies, and 39 diagnostic mammograms³⁴. In addition, the Department performed 970 electro-cardiograms, Holter Monitor and Event Recorder services.

Twice each week, films are sent by air cargo to Ottawa for interpretation and reporting by Diagnostic Imaging Consultants. Even though "positive" results are phoned to Iqaluit as soon as possible the practice of remote "reading" substantially increases the time from examination to diagnosis. Patients from the Baffin region who require imaging services not available at QGH are referred to hospitals or clinics in Ottawa and their travel costs are covered by the Nunavut Medical Travel Department.

The QGH Diagnostic Imaging Department has eight staff members:

- One x-ray/US technologist manager
- One vacant x-ray/US technologist
- One x-ray/mammography technologist
- One x-ray technologist
- One sonographer
- One Inuit basic radiology worker
- Two clerk interpreters

Imaging services are provided during regular weekday hours and the technologists rotate call schedules during evenings and on weekends. Ideally all staff would be trained in all modalities, thus maximizing the department's flexibility for on-call coverage, but this is rarely possible as dual trained technologists are particularly difficult to recruit.

Table 06 lists the imaging technologies in the Qikiqtani General Hospital.

Modality	Type	OEM	Model	Year	Archive
Radiographic Unit	Fixed	Toshiba		2006	CR
Radiographic/	Fixed		RTP9211GP5	1990 ³⁵	Not working

³⁴ Note: As the mammography service started only in November 2007, this figure represents less than half of the 2007/08 fiscal year.

³⁵ A business case is currently being developed for replacement of this non-operational unit. The unit will need to be transported by barge during shipping season .

Fluoroscopic					
Radiographic Unit	Mobile	DynaRad	DynaRad HE-110A 2		CR
Radiographic Unit	Mobile	Siemens	Mobilett XP Hybrid	2006/07	CR
Radiographic Unit	Mobile	Siemens	Mobilett XP Hybrid	1992	CR
Mammography Unit	Mobile	Planmed	Sophie Classic Maxview	2007	CR
Ultrasound Scanner	Fixed	Philips	Envisor HD	2005	Digital ³⁶
Ultrasound Scanner	Mobile	Sonosite	Micromaxx	2006	Digital

Since it has had the ability to use computed radiography (capturing an analog image and converting it to a digital image) the DI department has copied the images onto a DVD and then produced laser print films to send to radiologists in Ottawa for reading. Throughout QGH there are e-film stations where physicians can access and read their patients' images. This has served to reduce the number of films lost in the hospital.

In the past technologists have not been provided with funding to attend educational opportunities outside the Territory and they have had to pay their own way; however this is expected to change in the future as compliance to continuing education standards is being more stringently monitored and employers need to retain qualified staff.

Diagnostic Imaging Services in the Two Regional Facilities

Each of the two regional facilities is equipped with the technology to perform both x-ray and ultrasound examinations.

The Rankin Inlet facility, located in the Kivalliq region, employs one full-time x-ray technologist, one basic radiography worker, and has a contract with a sonographer from Winnipeg to provide locum service two weeks every month. Films from this facility are sent to Winnipeg for interpretation and reporting. In 2007/2008 the centre performed 2270 x-ray examinations and 382 ultrasound studies. The facility has one Toshiba x-ray room (2004), one portable DynaRad HF-110A x-ray unit (2000), and one Philips Envisor HD ultrasound unit (2004).

The Cambridge Bay facility, in the Kitikmeot region, currently lacks a sonographer and, with the exception of a visiting obstetrician/gynaecologist, is unable to offer ultrasound services. Every three or four months, the obstetrician/gynaecologist from Yellowknife travels to smaller community health centres in the region to perform ultrasound examinations. (It should be noted that as the only road in Nunavut connects Arctic Bay to the now closed mining community of Nanisvik, when technologists or others travel they must rely upon planes to transport them to and from the communities.) One full-time x-ray technologist and one basic radiography worker are employed by this facility. In 2007/08 Cambridge Bay performed 957 x-ray examinations and 78 obstetric ultrasound studies. Cambridge Bay has one Toshiba x-ray room (2005), two portable DynaRad HF-110A x-ray units, one Philips Envisor

³⁶ Although ultrasound images are stored on CD for the purpose of radiologist reporting, they are archived as prints on Sony print paper.

HD ultrasound unit (2005) and one Sonosite Micromaxx hand-carried ultrasound unit (2005).

In 2007/08, 453 of the x-ray examinations performed in the Cambridge Bay facility were sent to radiologists in Yellowknife for interpretation and reporting. The STH radiologists believe that due to cross-jurisdictional concerns, they need to be licensed in Nunavut in order to read DI examinations performed there. As Nunavut radiologist licensing requirements differ substantially from those in the NT, the STH radiologists would have to prepare, apply for and acquire an additional licence which would add to their already demanding schedules. As a result, when the radiologists attending STH are not licensed in NU³⁷, then STH forwards the Kitikmeot examinations to Edmonton for reading, thereby incurring a third step along the route from examination to report.

Patients from the Kivalliq region requiring other imaging services are referred to Winnipeg and those from the Kitikmeot region are referred to Yellowknife or Edmonton.

DI in the Community Health Centres

The 22 health centres provide basic x-ray services only. Each centre employs one or two basic radiography workers who perform x-ray examinations restricted to chests or extremities. Patients who urgently require more complex studies are referred to the health facility or the hospital in their respective region, or the nearest extraterritorial facility depending upon the imaging modality required. **Table 07** shows imaging examinations performed in 2007/2008. Note that Kivalliq region volumes are incomplete.

Table 07: Exam Volumes for health centres in each region

Region	X-ray	Ultrasound
Baffin Region		
Arctic Bay	264	18
Cape Dorset	380	7
Clyde River	324	10
Grise Fiord	27	0
Hall Beach	182	0
Igloolik	511	21
Kimmirut	77	0
Pangnirtung	580	13
Pond Inlet	526	30
Qikiqtarjuag	293	25
Resolute Bay	71	0
Total	3235	124
Kivalliq Region		
Arviat	n/a	
Baker Lake	*	
Chesterfield Inlet	333	

³⁷ Only one radiologist has applied for a Nunavut licence.

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Coral Harbour	260	
Repulse Bay	130	
Sanikiluaq	500**	44
Whale Cove	n/a	
Total	1223	44
Kitikmeot Region		
Gjoa Haven	206	60
Kugaaruk	171	41
Kugluktuk***	610	57
	1	405
Taloyoak	318	125

^{*}Biomedical Engineering estimated 2000 exams, but this number appears to be high.

** Examinations were not recorded for the 2007/08 fiscal year but the centre reported that 47 x-rays were performed in February 2009. This is a very rough approximation.

*** These are 2008 calendar year volumes.

Each regional facility forwards the films from the health centres in its region, along with its own films, to Ottawa (Baffin region), Yellowknife or Edmonton (Kitikmeot region), or Winnipeg (Kivalliq region). In 2007/08 QGH sent 3235 x-ray films and 124 ultrasound studies to Ottawa on behalf of the health centres in the Baffin region. The same year Cambridge Bay sent 995 x-ray examinations to Yellowknife for reading and the remainder to Edmonton, while Rankin Inlet sent 1223 x-rays and 44 ultrasound examinations to Winnipeg. Films from the 11 health centres in the Baffin region are entered into the DI module of the MediPatient system and stored at QGH; those from the seven centres in the Kivalliq region and the four centres in the Kitikmeot region are not filed centrally but are returned to the individual health centres for storage.

Each health care centre has a DynaRad HF110-A portable x-ray unit, acquired between 1999 and 2006, with the far majority having been purchased over the last four years.

Telemedicine

Although the Territory has developed a Telehealth system which is now available to all 25 communities, this network does not support sharing and viewing of diagnostic images. Canada Health Infoway and the Government of Nunavut have initiated a four-phase project to develop an electronic health record (EHR) throughout the Territory. The first phase of this project, anticipated to be completed by the end of 2009, is responsible for implementing a clinical information system in QGH. This system will then be expanded to three additional communities: Cambridge Bay, Rankin Inlet, and Pangnirtung. The second phase will determine what the teleradiology solution will be. By 2012, all communities in Nunavut will have access to the electronic health record, including digital imaging, storage, transmission to a radiologist, and retrieval capabilities. The electronic "filing" for each examination will be centralized at QGH. It is anticipated that the fully implemented EHR will reduce the turnaround time for diagnostic imaging results from 18 to three days. In order to support this project, the Nunavut Department of Community and Government Services is providing a much needed major upgrade to the communication infrastructure.

³⁸ Who interprets and reports the ultrasound examinations performed by the obstetrician/gynaecologist in the Kitikmeot region is not known.

Reported Status of Service Delivery

Standardized quality assurance measures take place regularly at QGH including: checking the CR readers and the mammography units; semi-annual preventative maintenance and ad hoc repairs on medical imaging equipment; and regular radiation safety inspections and reporting.

On behalf of the communities in the Baffin region, the QGH basic radiography worker reviews every film from the community health centres. If films are found to be satisfactory, then they are processed and sent along with any previous images/films to a radiologist in Ottawa for reporting. Otherwise the patient is recalled and the examination is repeated.

In the past there was a formal program to train workers in the Baffin region, which was a satellite of the Mohawk College program in Ontario. Reportedly, the Basic Radiology Worker program has now stalled somewhat and veered from its original direction, which was to train Inuit people to become skilled basic radiography workers and to allow them to bring these skills back to their communities. There is a need to re-energize the program and to regain the support it had in the past. The QGH DI Department expressed interest in assisting with this endeavour.

The QGH Department believes that its strengths include its recently acquired ability to produce digitized images through the acquisition of digital technology and CR readers. This has improved quality and, through the viewing of e-films, reduced the number of lost films. Recent completion of the accreditation process will also help to identify areas and methods for quality improvement. The need for a territorial position to plan, monitor and report on quality is thought to be required in order to improve, maintain, and standardize quality at a territorial level.

It is anticipated that the introduction of the EHR and the ability to send films electronically to outside centres will drastically reduce long turnaround times. Currently there are bandwidth issues in the region which restrict electronic transmission of images or other large communications to outside regular working hours; nonetheless the assumption remains that diagnostic images will be transmitted by means of a PACS solution.

The Territory has been involved with an ultrasound tele-imaging project established with Telesat Canada and the Canadian Space Agency. Ultrasound examinations are conducted via satellite with the radiologist at a medical centre viewing the procedure in real time and giving instructions to the sonographer who is conducting the examination in remote area. The sonographer at the remote site need must be qualified to perform the examination in this manner.³⁹ The system is considered to work very well and to be very valuable. It is hoped that it will continue to serve the Territory as it proved to have great potential to address urgent patient requirements in remote areas.

With respect to equipment, a business case is being developed to replace the fluoroscopy unit at QGH as the current unit is approximately 20 years old. There is also a potential business case to be made for introduction of CT technology in the region, in particular for the management of CVA and trauma patients; however there are not enough data to support such an acquisition at this time.

³⁹ This initiative apparently started in Calgary and Banff with staff that had minimal/no training. In Nunavut the only trained staff member is the DI manager.

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Discussion

Equipment: For the large part imaging technology in the three territories is limited in range, but current. In the Whitehorse General Hospital, all units of technology are less than ten years of age and in spring 2009 the CT scanner will be upgraded from 4-slice to at least 64-slice. The Watson Lake Hospital has a five-year old portable x-ray unit and the 12 rural community health centres have portable x-ray units ranging from four to ten years of age. Although there is no indication that any of this equipment is currently in need of replacement from the perspectives of technical or functional obsolescence, during the course of this project WGH noted that their equipment is currently up to date but they are in need of a plan for equipment renewal in order to maintain this state and have the necessary funds set aside. This need was underscored in the current YHC Strategic Plan which stated the need for strategic capital equipment and project planning in order to maintain the hospital's strong infrastructure.

In the Northwest Territories, all of the imaging technologies at STH, with the exception of the 13 year old mammography unit, were purchased within the past four years. The Inuvik Regional Hospital and the H. H. Williams Memorial Hospital have a mix of current and out-dated technologies. They each have a radiographic unit that is more than 12 years old, but they also have units that were purchased within the past four years. The ultrasound units at each site need to be considered for replacement. The mammography unit at the IRH is now ten years old while the one at the HHWMH was purchased within the past year. The radiography units and the ultrasound scanner at the Fort Smith Health Centre are all current technology. The community health centres have portable x-ray units, most of which were purchased in 2005 but they report that many centres are making do without proper x-ray tables. Inadequate space may limit the accommodation of this need.

With only a few exceptions, the imaging units in Nunavut are reasonably current. One general radiographic/fluoroscopic unit at the Qikiqtani Hospital is at least 19 years old and is in dire need of replacement. QGH also has a 17 year old mobile radiographic unit. Otherwise, its three radiographic units, two ultrasound scanners and one mammography unit were each purchased within the past four years. With the exception of a nine-year old radiographic unit in Rankin Inlet, all other imaging technologies in the two regional facilities are less than five years old. The mobile x-ray units in the rural community health centres are between four and ten years old, with the majority having been purchased in 2005.

Due to difficulties inherent in developing films in the cold climate of Canada's northern territories (developer can freeze during transportation and static electricity can interfere with developing films), production of digital images is preferable. Electronic transfer of digital images between the examination site and the "reading" site also enables faster turnaround time between examination and report. In the Yukon, all images produced at the WGH are currently in digital format and the initiative that will soon introduce CR technology to Watson Lake Hospital and the rural health centres will eliminate the need for processing of films altogether. Similarly in the Northwest Territories, the Canada Health Infoway project, which is currently installing PACS in STH and the three other hospitals, and introducing CR units into the community health centres, will ultimately result in all images being stored in digital format. In both of these territories the PACS will allow films from all centres to be transmitted electronically for review and reporting. Nunavut is in phase one of a project to develop an EHR. This project will connect QGH with communities in the Baffin region, with the head cities and communities in each of the other regions, and

with radiologists in Ottawa. By 2012 it is anticipated that images from all facilities in the Territory will be in digital format and transmitted to centres in the south for review and reporting, thus reducing the turnaround time from examination to report from 18 to three days.

During the course of this project it was not possible to determine the number of people who are referred to centres in provinces south of the three territories for imaging examinations, nor the costs associated with these referrals. The question remains "would it be more cost effective to introduce new technologies into the territories and avoid the need for some medical travel?" There may be a potential to develop business cases, such as for a CT scanner in Nunavut.

The difficulties associated with recruiting and retaining qualified MRTs in the three territories also need to be considered when evaluating whether new imaging technologies should be acquired, as additional technologies would likely drive the need for additional qualified technologists.

Telemedicine: The advantages of having the ability to transfer images electronically are indisputable and soon most, if not all, of Canada's northern regions will be able to do so. The Yukon is currently effectively using its PACS and telehealth to transmit images from the WGH to Edmonton for review and reporting. Up until this point in time, its telehealth system supported the transfer of diagnostic images between the WGH and rural communities for emergency purposes only. When the PACS system expands in the near future all sites in the territory will be able to transmit to Edmonton via the WGH. In the Northwest Territories, all facilities outside Yellowknife will soon have the ability to store images in digital format and send them to the STH for reporting. The existing teleradiology system in the NT has never been fully utilized; nonetheless it is anticipated that combined with the new PACS, the system will serve the Territory well when the STH is short of radiologists, during these times review and reporting of images could be performed remotely.

Although Nunavut has a telehealth system that is available in 25 communities the system does not support sharing and viewing of diagnostic images. The Government of Nunavut and Canada Health Infoway are undertaking a project that will develop an EHR throughout the Territory. By 2012, all communities in Nunavut will have access to the electronic health record, including digital imaging, storage, transmission to a radiologist, and retrieval capabilities. The QGH reported that its involvement with Telesat Canada and the Canadian Space Agency in a tele-ultrasound imaging project that conducts diagnostic imaging examinations via satellite⁴⁰ has been very valuable and they hope that these services will be able to continue as they could potentially provide a solution to the management of urgent needs of patients in remote locations.

The need for secure modes for transmission of diagnostic images is unquestionable, as confidentiality becomes an issue when a secure network is not available. This has been the case when emergency situations have arisen that necessitated digital photos of films to be transmitted via email. In these cases, patient need was met but with the risk of breach of confidentiality.

Examinations: Without knowing how many people were referred to southern centres for diagnostic imaging examinations it is not possible to even approximate total DI utilization in any of the three territories. Assuming that each territory provided its

⁴⁰ A professional at one centre guides the person performing the examination in a remote area.

residents with the majority of their general radiography, ultrasound, and CT examinations, it is possible to provide a rough estimate for utilization in these modalities. **Table 08** outlines the number of examinations provided by each territory per 1000 persons in 2007/2008 as well as total utilization, which is known to be incomplete.

Table 08: 2007/2008 Modality Utilization for Each Territory (# per 1000 persons)

Modality	Territory or Province					
	Yukon	Northwest Territories	Nunavut*	Province** 2003/2004		
General Radiography	527	784	400	888		
Ultrasound	113	222	78	209		
CT	73	81	n/a	83		
Total	713	1087	478	1217***		

^{*} Does not include x-ray examinations performed in some Kivalliq region health centres

Based on the Consultant team's experience, facilities in the Northwest Territories appear to be performing a very large percentage of the imaging examinations received by the Territory's population. In 2004 the CAR⁴¹ estimated that Canadians were receiving approximately one examination per person annually: when adjusted for growth this figure increases to 1.14 examination per person in 2008. Given that residents of the NT travelled to southern centres to receive nuclear medicine and MRI examinations raising their total utilization over 1.087 exams per person, they appear to have been well served in 2007/08. The populations of the Yukon and Nunavut either received far fewer imaging examinations per 1000 persons, or a far greater percentage of the population was referred to southern centres. Also, we know that the statistics for Nunavut do not reflect the total number of DI examinations performed, as several health centres were not able to provide examination statistics. The very remote nature of Nunavut and the limited transportation infrastructure could be expected to limit travel for elective medical purposes. It would be of interest to know the referral statistics for the three territories and hence more about their modality and total utilization. A detailed analysis of disease prevalence, health determinants and population demographics would also serve to provide more insight to the variation in the territories' modality utilization figures.

It is also of interest to examine the longitudinal trends in the territories. All three reported that demand increased every year, particularly for ultrasound and CT studies. Without performing in-depth analysis, it can be seen that four factors support these trends:

- The Yukon and Nunavut, and to a lesser degree the Northwest Territories, have witnessed population growth greater than the Canadian average. There is no evidence to suggest that DI utilization per capita is falling, therefore a larger population leads to greater demand.
- For each territory the largest component of population growth occurred in the segment over 60 years of age, a group that is known to consume approximately four times the number of imaging exams⁴² as do younger persons. As this group becomes more prevalent, it can be expected to drive

⁴¹ Normand Laberge, Canadian Association of Radiologists, personal communication, 2004. It should be noted that this figure has been validated many times in the Consultants' experience.

^{**} Unidentified to protect confidentiality

^{***}Includes MRI and nuclear medicine

⁴² Bhargavan M, Sunshine JH. Utilization of radiology services in the United States: levels and trends in modalities, regions, and populations. Radiology 2005;234(3):824-832.

additional demand for all imaging modalities, especially CT and general radiography examinations.

- Compared to the Canadian average, the territories have relatively young
 populations coupled with significant growth in the group aged 20 to 29 years of
 age. Females of child bearing age stay connected with the health care system
 and in respect of diagnostic imaging, create additional demand for ultrasound
 studies. In particular, this would be the case in Nunavut where females
 outnumber males and are known to have a high fertility rate.
- The phenomenon known as "DI growth" is recognized to contribute to increasing DI utilization. "DI growth" represents the enhanced contributions to clinical care that the field has been proven to make as its technologies develop. Although much of this growth is attributed to advances in MRI technology, CT and ultrasound technologies also contribute significantly.

Without knowing historical examination statistics or the number of examinations that are (and have been) carried out in southern centres, in-depth analyses of current utilization or projection of trends for the future cannot be performed. These analyses would be very valuable for planning services, equipment, staffing, and space that the territories will need in the future. There is one certainty though: that demand will continue to grow in each territory, especially as their populations increase and, at the same time, become older.

Administrative structure: With the exception of the Northwest Territories, the DI administration of the regional hospital(s) does not govern DI services in the rural community health centres. Furthermore, in all three territories, the rural/remote managers do not possess a DI background. Throughout the project it was obvious that a large degree of help and cooperation exists between DI providers in each territory; nonetheless, there appear to be few common standards and expectations. The lack of common standards became obvious when requesting statistics, details on quality and radiation protection programs, and information on staff credentials. Generally administrators are busy and are stretched to manage their own facility, let alone take on additional responsibility. If they were to do so they would require more resources, but the enhanced quality might make the cost worthwhile.

Human Resources: Two issues are apparent concerning the DI technological workforce: there are ongoing challenges associated with recruiting and retaining qualified technologists; and there is a need to develop competencies, standards, and training programs for x-ray workers in rural and remote communities.

Recruitment and retention of qualified medical radiation technologists (MRT) is a challenge across Canada, not only in the territories. It is made worse for the territories due to their need to hire dual trained personnel to maximize on-call coverage. Being small departments, they have little flexibility for coverage and when they are short-staffed patient care is adversely affected. These departments have little potential to maintain a casual pool as most workers would require a substantial volume of work in order to be willing to remain in a pool, an amount which is beyond that which very small departments could offer. A joint territorial human resource initiative might help to alleviate some of these issues.

There appear to be few formal programs to train basic x-ray workers in the rural community health centres. The Oshki-Pimache-O-Win Education and Training Institute, in Thunder Bay Ontario, offers a Basic Radiological Technician course, ⁴³ but it is primarily focused upon First Nation residents of Ontario. This program is

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⁴³ http://www.oshki.ca/calendar

endorsed by Health Canada, OAMRT⁴⁴ and the CAMRT. In the Yukon, where x-rays in rural centres are performed by primary care nurses, training is performed on an ad hoc basis by MRTs from the WGH when they are able to find the time. Between training sessions, the nurses pass along their knowledge to other nurses. In the NT, where nurses and housekeeping staff perform x-rays they report that training is supplied by Aurora College (NT), but only on an ad hoc basis. The MRTs from the STH used to provide training until they found it too difficult to sustain during periods of staff shortages. Nunavut reported that Mohawk College no longer offers a basic radiography worker program to workers in the Baffin region but they would like to assist in having it reinstated.

Nunavut has established radiologist licensing requirements that require radiologists from other jurisdictions, if they are going to review and report examinations performed in Nunavut, to prepare, apply for, and acquire the licence. Currently, this requirement appears to be hampering radiologist availability for remote reading of imaging examinations; however, if interprovincial licensure were to become a reality, it could serve to increase the number of radiologists willing to provide locum services in the Territories.

Quality: Again, when personnel with administrative responsibilities are very busy, they find it difficult to create, organize, and maintain a standardized image and radiation protection quality assurance program. Furthermore when training in the rural community centres is neither formal nor standardized, education on various aspects of quality improvement is most likely lacking. The fact that the health centres and the regional hospitals are not under the same organizational structure further diminishes opportunities for learning about quality techniques, measures, and standardized programs. Even in the NT where all centres offering DI services are operated under one administration, there is a reported need for an ongoing imaging and radiation protection quality assurance program throughout the Territory to monitor aspects of service delivery such as wait times, repeat rates, etc. There is no radiation protection officer, a position which could be shared amongst the three territories. The three territories share two territorial representatives, at the national level, on the Federal Provincial Territorial Radiation Protection Committee (FPTRPC).

Data: During the information collection phase of this project, two things became clear: data is collected by many different people, and for territories where DI services do not operate under one administration, there exists a lack of consistency in data collection. Although the data for the Yukon and the Northwest Territories was available, it required contacting a number of sources. In Nunavut, with the exception of the Baffin region, the delivery of DI services was administered through the director of the regional health facility, yet each health centre within the region was responsible for collecting its own examination data. In a number of cases, examination statistics did not appear to be maintained. When data collection is not standardized, cross-sectional or longitudinal analysis becomes impossible, which in turn impedes the ability to plan well. The only territory that collects uniform data has one administration common to all facilities that provide DI services.

There appear to be a number of areas related to the delivery of DI services in all three territories that have the potential to be explored as collaborative ventures. Development in these areas should lead to improvements in the quality of service to

⁴⁴ The OAMRT outlines a job description, terms of employment and bylaws for the Society of Basic x-ray workers. See http://www.oamrt.on.ca/index.php

patients as well as in the work lives of care providers. Such opportunities will be discussed in the concluding section of this report.

Project Limitations

Administrators/managers of small imaging departments typically find themselves very busy performing a wide range of functions including patient care. This was certainly the case in each of the three territories, made worse in the Northwest Territories and Nunavut by ongoing staff shortages. Furthermore, the STH was about to implement its new PACS in early March and QGH was participating in the hospital accreditation process during the last week of February. Given their competing demands, the managers of all the departments should be given immense credit for having made themselves available and provided the valuable information reported herein.

With the exception of the Northwest Territories, there was no common administration of DI services across the regional hospital, other hospitals, and the health centres. In order to collect comprehensive data, the information could not be collected from one central source; therefore many contacts needed to be initiated and developed. Also, the statistics were often reported inconsistently, thus increasing the amount of follow-up required.

Being aware of the managers' time constraints did, to some degree, impact upon the data collection process. Wherever possible the Consultant team sought other sources, including the Internet, for more generic background information; thus incurring the risk of reporting outdated or inaccurate information. Also, the consultant team was limited in the degree to which it continued to return to the sources to seek clarifications. As a result it was not possible to collect, clarify, and report every detail within the scope of this report.

Each territory's initial draft report was shared with its respective manager(s) for review and the draft was subsequently revised to reflect the comments received. By way of this approval process the content of this report has been validated.

Had additional details on the following topics been available, then they could have allowed for more in-depth discussion and added value to the recommendations:

- The method of payment for imaging services is presented at a high level only. Better understanding could have helped understand the financial costs involved when locum radiologists are employed and when images are transferred physically or electronically to other sites for interpretation and reporting.
- Information on the transfer of people for imaging services within and outside each territory, including numbers, destinations, and costs, would have allowed some insight into the magnitude of costs involved when a jurisdiction is not able to sustain certain modalities.
- Details of examination totals and types were not all available and were not presented consistently within or across territories. Consistent and complete statistics would have allowed for better comparisons.

Conclusions

The delivery of diagnostic imaging services in the three territories exemplifies some of the challenges associated with small departments, in particular those serving rural and remote areas.

In all territories imaging technologies, though limited in range, are reasonably up to date and not in short supply when compared to more urban regions. While imaging

technologies may be current at this point in time, two territories stated the need for a plan which articulates future DI needs. Such a plan would ensure that capacity for each modality, equipment, staffing and space needs are anticipated in advance of when they are required and that funding is set aside.

Recent projects to introduce PACS and enhance the telehealth systems in the Yukon and Northwest Territories have allowed all images to be stored in digital format and sent electronically from site to site for interpretation and reporting, thus providing more flexibility and alleviating some difficulties associated with maintaining radiologists onsite. Electronic transmission of images also improves patient care by reducing the time from examination to report. Nunavut has recently embarked upon a similar project and is expected to see the same benefits by 2012.

Recruitment and retention of technologists is an issue in all territories. The lack of locum staff could potentially be offset if a casual pool common to all three territories were developed. Such a pool would not only alleviate staffing deficiencies, but could start to introduce common standards and practices amongst the hospitals. Travel costs may become an issue, but these might be offset by some savings associated with sharing standards and practices.

X-rays are delivered by nurses in community health centres in the Yukon and by a combination of nursing and non-nursing staff in the other two territories. Currently, nurses in health centres in the Yukon do not have any type of formal x-ray training program. Basic x-ray workers in health centres in Nunavut's Baffin region have recently lost their training program offered by Mohawk College and those in heath centres in the Northwest Territories are trained by Aurora College, but only on an ad hoc basis. Enhanced training opportunities for basic x-ray workers in Canada's North could serve not only to enable staff to increase their scope of work, but also to expand and standardize quality practices. There is a stated need to develop a set of competencies for the delivery of imaging services in rural and remote areas. Also, the development of web-based modules that could supplement other forms of on-site training is thought to be one way to assist with basic radiography workers' learning needs.

One deficiency that became obvious through the project was the lack of time available to supervisors/managers, especially those who also carry a patient load. The individuals do not appear to have the time or other resources available to assist them in planning or other administrative functions, especially when patient care is their priority.

With the exception of the NT, the administrators managing DI services in rural and remote areas are not the same as those managing the DI departments in the regional hospitals and they do not possess a DI background. This separation deepens the need for training programs and quality standards that can be easily practiced in these regions. In the past, the DI technical supervisors from the WGH and the STH provided training opportunities in the health centres, but they are no longer able to do this, due to time constraints.

Some opportunities became apparent through involvement with this project including:

 Assistance with planning for the future including: the capacity projections for each modality; the costs and benefits associated with the potential acquisition of new technologies; equipment replacement and upgrade requirements; projected staffing requirements; and associated space needs.

- The development of collaborative equipment purchase and maintenance programs.
- An inter-territory human resource initiative that might serve to investigate and improve recruitment activities, develop a common locum pool, and investigate and establish requirements that are needed to retain staff.
- An inter-territory initiative that would establish competencies associated with the delivery of basic x-rays in rural and remote settings.
- The development of web-based modules to supplement on-site basic x-ray worker training. These would focus upon practices associated with performance of x-rays and standards associated with radiation protection and image quality.
- Assistance in the development of quality standards and a methodology that could serve in the rural and remote communities across all territories.
- An initiative to investigate options and to advocate for the development of universal Canadian licensure for radiologists. This initiative might also advance the practice of remote "reading" of imaging examinations by investigating and clarifying licensing requirements when exams are "read" in a jurisdiction other than that where the examination was performed.
- An inter-territory initiative that might explore options for the delivery of continuing professional development programs across all territories, perhaps in conjunction with national and/or provincial professional associations.

Acknowledgements

The Consultants wish to acknowledge the positive participation of Yukon, Northwest and Nunavut territorial representatives for their insight and many contributions to the successful outcome of this project. In addition, we want to thank those who willingly gave their time and support in this endeavour.

While some issues may have been identified within the report, we feel it is important to note that these are opportunities for improvement and that there are many positive aspects in the delivery of medical imaging services in each of the Territories including a high commitment to patient-focused care and each has a territory-wide desire to work with one another to improve the current environment in order to provide the optimum care for their residents.

Your assistance and patience has been most appreciated and it has been a privilege to be part of this process.

ProMed Associates Ltd

Appendix

Appendix 1: Northwest Territories: Equipment and Examination Volumes in each Heath Centre

Town/City	Site Name	X-ray	OEM	Auto Processor	Exams- 07/08
Aklavik	Susie Husky Health Centre	yes	DynaRadHF110	agfa-cp1000	155
Behchoko	Marie Adele Bishop Health Centre	yes	DynaRad HF110	agfa-cp1000	434
Colville Lake	Colville Lake Health Centre	yes	DynaRadHF110	agfa-cp1000	19
Deline	Deline Health Centre	yes	DynaRad HF110	agfa-cp1000	141
Fort Good Hope	Fort Good Hope Health Centre	yes	DynaRad HF110	agfa-cp1000	146
Fort Liard	Fort Liard Health Centre	yes	DynaRad HF110	agfa-cp1000	149
Fort McPherson	William Firth Health Centre	yes	DynaRad HF110	agfa-cp1000	175
Fort Providence	Fort Providence Health Centre	yes	DynaRad HF110	agfa-cp1000	298
Fort Resolution	Fort Resolution Health Centre	yes	DynaRad HF110	agfa-cp1000	156
Fort Simpson	Fort Simpson Health and Social Services Centre	yes	Gemdex rm		included below
Fort Simpson	Fort Simpson Health and Social Services Centre	yes	DynradHF110	agfa-cp1000	726
Lutsel k'e	Lutsel k'e Health Centre	yes	DynaRad HF110	agfa-cp1000	149
Norman Wells	Norman Wells Health Centre	yes	DynaRad HF110	agfa-cp1000	165
Paulatuk	Paulatuk Health Centre	yes	DynaRad HF110	agfa-cp1000	113
Rae Lakes	Gameti (Rae Lakes) Outpatient Centre	yes	DynaRad HF110	agfa-cp1000	162
Sachs Harbour	Sachs Harbour Health Centre	yes	DynaRad HF110	agfa-cp1000	62
Tuktoyaktuk	Rosie Ovayouk Health Centre	yes	DynaRad HF110	agfa-cp1000	255
Tulita	Tulita Health Centre	yes	DynaRad HF110	agfa-cp1000	201
Ulukhaktok (previously Holman)	Emegak Health and Social Services Centre	yes	DynaRad HF110	agfa-cp1000	112
Wekweti	Wekweti Community Wellness Centre	na	Unit loaned from STH	n/a	34
Wha Ti	Wha Ti Health Centre	yes	DynaRad HF110	agfa-cp1000	133
				Total	3785