MEDICAL RADIATION TECHNOLOGISTS

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Medical Radiation Technologists

Introduction

Medical radiation technologists (MRTs) are defined by the National Occupational Classification as healthcare professionals who "operate radiographic and radiation therapy equipment to administer radiation treatment and produce images of body structures for the diagnosis and treatment of injury and disease" (Government of Canada, 2016). MRTs deliver quality care to their patients through an extensive understanding of the principles of anatomy, physiology, pathology, image acquisition, treatment and radiation protection, combined with expert knowledge of imaging and radiation therapy equipment (Canadian Association of Medical Radiation Technologists [CAMRT], 2015). They provide safe, appropriate, tailored and timely care using the maximum potential of the available equipment and resources (CAMRT, 2015).

Medical radiation technology is a challenging and sophisticated profession that is growing quickly due to continuous advancements in technology, procedures and patient care. Between 2006 and 2015, the profession grew by 17.7% (Canadian Institute for Health Information [CIHI], 2017). MRTs practise in many disciplines, including radiological technology, radiation therapy, nuclear medicine and magnetic resonance imaging (CAMRT, 2014). They work in hospitals, cancer treatment centres, clinics, radiological laboratories, colleges and universities (CICIC, 2020).

MRTs provide service in both the public and private sectors, working both independently and in collaboration with other healthcare professionals, including specialists in radiology and radiation oncology to provide diagnosis, treatment and other care (CAMRT, 2014). They also play important roles as patient advocates, educators, healthcare researchers, technical and therapy specialists, interdisciplinary consultants, and in management and leadership positions.

History of the Profession

X-rays and radiography technology

Wilhelm C. Roentgen's 1895 discovery of x-rays and how to use them to make images laid the path for diagnostic medical imaging (Seibert, 1995). Because Roentgen did not patent his invention, other scientists and physicians began experimenting with x-rays. This led to a dramatic change in medicine, suddenly providing practitioners with the ability to visualize structures within the human body.

The importance of x-rays became evident during the First World War. Scientist Marie Curie realized that using x-rays in the field would allow doctors to see bullets, shrapnel and broken bones, and could save the lives of many soldiers (American Institute of Physics, 2015). She convinced the government to allow her to set up France's first military radiology centres, becoming the Director of the Red Cross Radiology Service (American Institute of Physics, 2015). Because mobility was essential for deploying x-ray technology in the military field, Curie secured financial support from wealthy benefactors and convinced automobile body shops and manufacturers to serve their country by donating automotive equipment and services (American Institute of Physics, 2015). The first 20 radiology vehicles equipped to transport x-ray equipment to wounded soldiers at the battlefront were ready by late October 1914 and were soon dubbed *petites Curies* (little Curies) by French enlisted men (American Institute of Physics, 2015).

After the war, the use of x-rays and radiography spread to hospitals, becoming an indispensable service, especially in tuberculosis screenings (Siemens, 2012). As the use of x-rays increased, the technology developed rapidly. Some key developments include:

- The use of contrasting enhancing products and the development of the x-ray sphere in the 1930s;
- The commercial availability of angiography in 1951;
- The emergence of radiation therapy as its own discipline in 1956;
- The introduction of ultrasound technology in 1961;
- The development of computed tomography (CT) in 1972; and
- The introduction magnetic resonance imaging (MRI) in the early 1980s (Siemens, 2012).

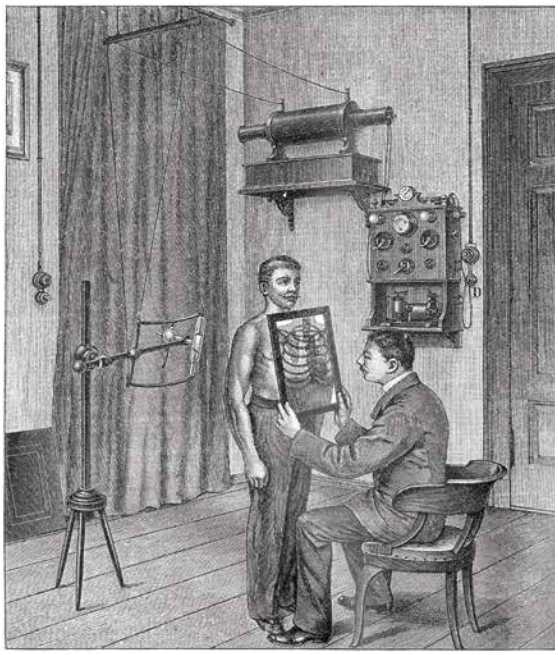
Professional societies

The earliest x-ray examinations were performed by physicists and physicians interested in this new field (Harris, 1995). As the demand for the new diagnostic capabilities offered by x-rays increased, so did the need for trained technical assistants. The first standardized training courses for x-ray assistants started during the First World War (Crowley, 1948). Eddy C. Jerman, founder of the educational department of the General Electrical Corporation, published the textbook *Modern X-Ray Technic*, which became the foundation for all technicians (Harris, 1995).

As the number of x-ray technicians grew, professional societies began to form. American and British radiological technicians formed societies to recognize their members and establish standardized certification methods throughout the 1920s and 1930s (Ehlert, 2008). During this period, Canadian technicians were certified by the American Society of X-Ray Technicians (Ehlert, 2008). In 1929, the Western Society of Radiographers was organized by Claude Bodle and William Doern (Crowley, 1948), as a precursor to the Canadian society.

In 1942, the Canadian Society of Radiological Technicians, now known as the Canadian Association of Medical Radiation Technologists (CAMRT), was created. That same year, the organization dissolved its affiliation with the American Society of X-Ray Technicians (Crowley, 1995). Canadians now obtained certification through provincial examinations approved by the new society (Ehlert, 2008). In May 1945, following the introduction of a new curriculum for MRT designation, the first Canadian certification exams were held. The first training syllabus was then established in 1950 (Ehlert, 2008). MRT training and certification were standardized throughout the 1950s and today remain largely unchanged from this initial model (Crowley, 1995). National certification exams for radiation therapy and nuclear medicine were added in the 1960s, and a certification exam for magnetic resonance was added in 1999 (Ehlert, 2008).

In the early years, technicians could train at an established training centre, by formal study at a college or university, or by a directed two-year course in a department of radiology with more emphasis on clinical expertise than theoretical study (Crowley, 1948). Today, education is delivered through colleges and universities. CAMRT continues to play an important role nationally as the certification body for MRTs (as well as a professional association).



The evolution of MRT practise

The MRT profession continues to evolve rapidly due to the ever-changing needs of patients and advancement of technology. Technologies such as artificial intelligence and hybrid technologies will dramatically affect entry-to-practise programs and the practise environment.

Optimizing the MRT scope of practise to better serve patients is at the core of what CAMRT is trying to accomplish. This can be achieved by strengthening the core responsibilities of MRTs, engaging MRTs into collaborative partnerships with other healthcare providers, and exploring and developing advanced practise roles to improve patient outcomes.

TABLE 1: Timeline of the medical radiation technology profession

1895	Discovery of x-rays
1920s	Formation of the earliest professional societies for x-ray technologists (called technicians at the time)
1942	Incorporation of the Canadian Society of Radiological Technicians (now CAMRT)
1945	Standardization of education across Canada First Canadian national designation and exam
1956	Recognition of radiation therapy as its own discipline First course specifically dedicated to radiation therapy
1966	Recognition of nuclear medicine as its own discipline
1973	First CT scanner in Canada
1982	First MRI scanner in Canada
1996	Recognition of MRI as its own discipline
2002	First positron emission-CT (PET-CT) scanner in Canada
2012	First PET-MRI scanner in Canada

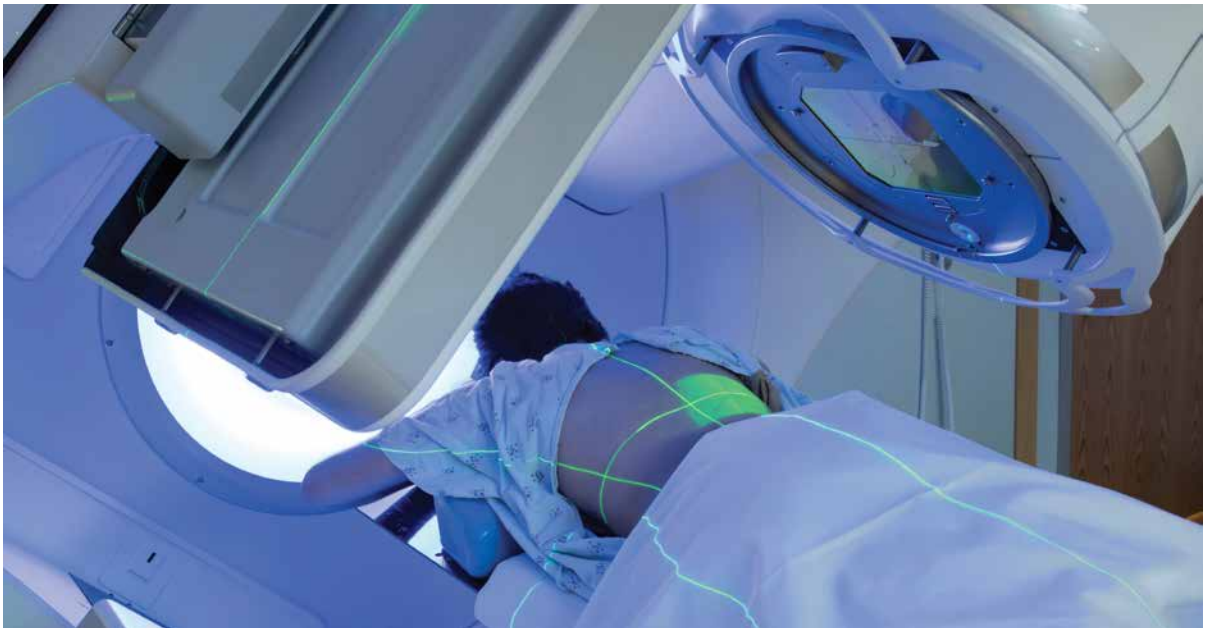
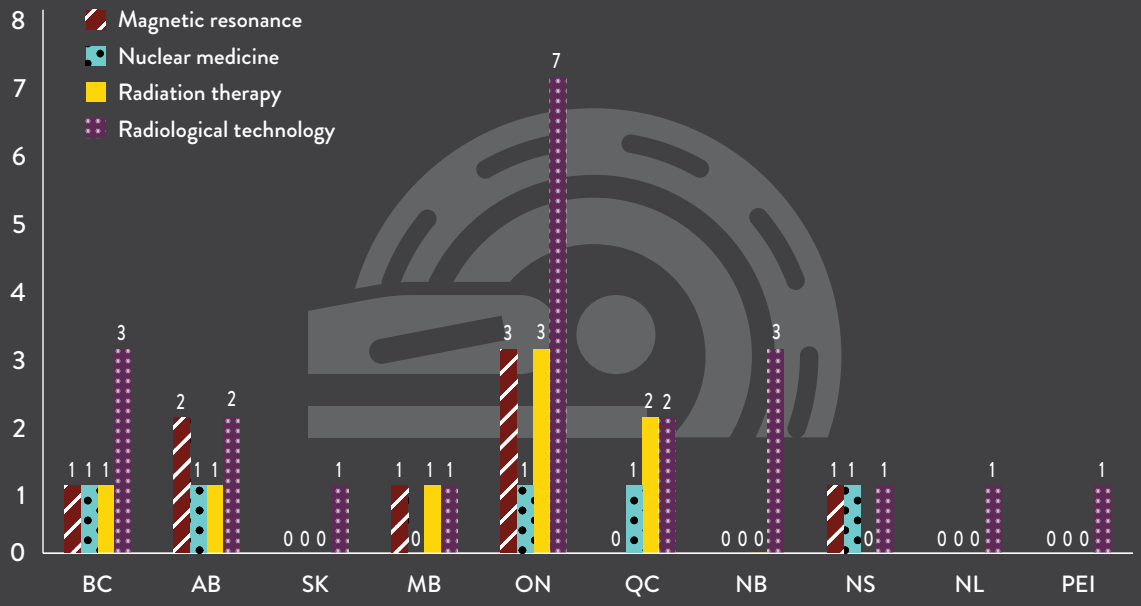


Figure 1: Accredited programs per province



Source: CAMRT. *Certification*. Retrieved from https://www.camrt.ca/certification-3/

Education and Training

The basic requirement to enter an accredited MRT educational program is a Canadian high school diploma. Additional entry requirements vary among institutions, making it difficult to provide a list of required courses. However, programs generally require candidates to have a strong science background, and some have minimum grade point average requirements. Therefore, prospective students should investigate individual institutions' program entry criteria.

MRT programs across the country also vary in length of study, and there are diploma and degree programs available in magnetic resonance, nuclear medicine and radiological technology. The national entry-to-practise standard for radiation therapy is a degree. Programs accredited by Accreditation Canada are available in each of the four disciplines (see Figure 1).

Certification

After successfully completing an accredited MRT education program, graduates are eligible to write the national certification examination administered by CAMRT. Passing the certification exam makes them eligible for licensure with their respective provincial regulatory bodies. Both Canadian and internationally educated MRTs are required to register with a provincial regulatory body to practise in Canada.

Internationally educated MRTs

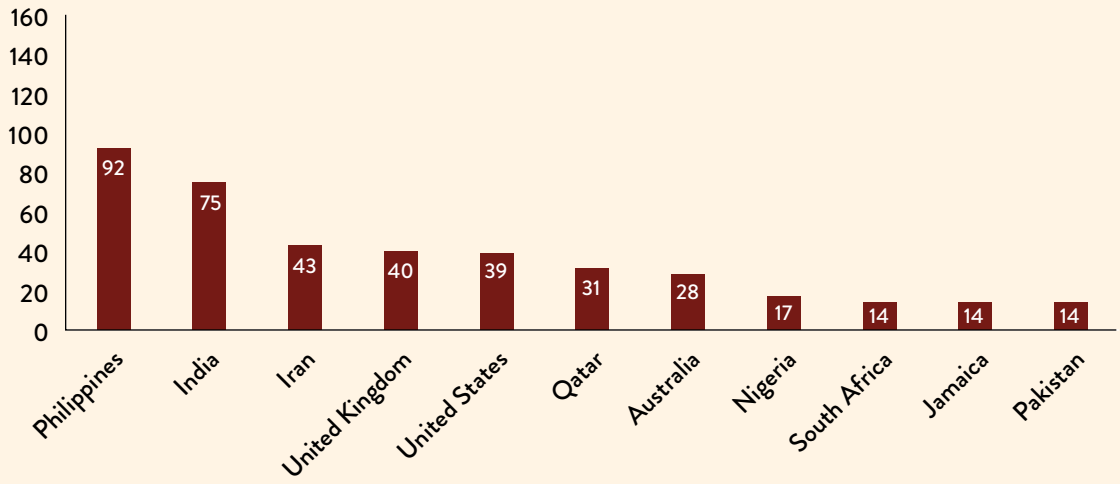
Before internationally educated MRTs (IEMRTs) can write the national entry-to-practise certification exam, which is required to practise in most Canadian jurisdictions, their credentials must be assessed. This assessment includes a review of the following criteria:

1. Similarity of the educational program completed by the IEMRT to an accredited Canadian program;
2. The IEMRT's clinical competence and the currency of their work experience;
3. Language proficiency in at least one of the official languages of Canada; and
4. Other jurisdictional specific requirements (CAMRT, 2022).

Alberta, Ontario and Québec have developed their own assessment processes and complete independent reviews. Saskatchewan and Nova Scotia require provincial based applications first before credential assessment by CAMRT. The remaining provinces and territories rely on CAMRT to assess IEMRTs' credentials (CAMRT, 2022). Once the assessment is complete and an IEMRT is determined to be eligible, they may apply to write the certification exam. Figure 2 shows the top 10 countries of origin of IEMRTs who wrote the CAMRT exam between 2017 and 2021. The province of Québec also administers its own certification examination (CAMRT, 2022).

IEMRTs can learn more about these courses and register for them through CAMRT's website at www.camrt.ca.

Figure 2: IEMRTs writing the CAMRT exam by country of origin (top 10) 2017–2021



Source: CAMRT database

Regulation of the Profession

The medical radiation therapy profession is currently regulated in six provinces: Nova Scotia, New Brunswick, Québec, Ontario, Saskatchewan and Alberta. The provincial medical radiation therapy associations in the remaining four unregulated provinces are currently lobbying their respective provincial governments to become self-regulated. None of the territories are currently regulated and, due to the small number of MRTs in those jurisdictions, they are unlikely to become regulated. Table 1 highlights the regulation of MRTs in Canada.

TABLE 2: Regulation of MRTs in Canada

Province	Year	Act	Provincial regulatory body
New Brunswick	1940	New Brunswick Companies Act	New Brunswick Association of Medical Radiation Technologists
Saskatchewan	1940	Medical Radiation Technologists Act	Saskatchewan Association of Medical Radiation Technology
Québec	1973	Loi sur les technologues	Ordre des technologues en imagerie médicale en radio-oncologie et en électrophysiologie médicale du Québec
Ontario	1991	Medical Radiation Technology Act	College of Medical Radiation and Imaging Technologists of Ontario
Alberta	2004	Medical Diagnostic and Therapeutic Technologists Profession Regulation	Alberta College of Medical Diagnostic and Therapeutic Technologists
Nova Scotia	2011	Medical Imaging and Radiation Therapy Professional Act	Nova Scotia College of Medical Imaging and Radiation Therapy Professionals
Prince Edward Island	2021	Regulated Health Professionals act, 2021	College of Allied Health Professionals

Scope of Practise

MRTs use their expert knowledge of imaging and radiation therapy equipment—together with an extensive understanding of the principles of anatomy, physiology, pathology, image acquisition, treatment and radiation protection—to deliver quality care to their patients. MRTs provide safe, appropriate, tailored and timely care that maximizes the potential of available equipment and resources. They also take a patient- and family-centered approach to care to protect patient rights and confidentiality, and to promote patient communication and education (CAMRT, 2015).

To ensure patients receive the most appropriate care and the highest quality outcomes, MRTs may assess patients' clinical information, deliver requested examinations and prescriptions, gather information, and collaborate with other healthcare providers (CAMRT, 2015).

Following the "as low as reasonably achievable" principle, MRTs apply their knowledge of radiation effects and risks to minimize the doses received by their patients, other healthcare colleagues and the public, providing the safest environment possible (CAMRT, 2015).

Table 3 provides a brief overview of each MRT discipline and some of the discipline-specific skills required to practise.

TABLE 3: Specialty disciplines within radiation technology

Discipline	Description	Core discipline-specific skills
Magnetic resonance technology	Magnetic resonance technologists produce diagnostic images using equipment that generates radio waves and a strong magnetic field.	• Detecting subtle abnormalities within the brain and spinal column • Examining tissue of the joints, muscles, ligaments and tendons • Providing detailed studies of major organs including the breasts, liver, spleen, kidneys, urinary system, and male and female sexual organs • Viewing the workings of the heart and vascular system • Studying body chemistry and functions
Nuclear medicine technology	Nuclear medicine technologists carry out diagnostic imaging and some treatment procedures in hospitals or private medical clinics. They obtain the images that help pinpoint the nature of a disease and how it is affecting the body.	• Evaluating coronary disease • Studying how the brain, heart, lungs, kidneys and other organs are functioning • Determining the location of tumours • Monitoring the progression of cancer and the results of cancer treatments • Diagnosing hormonal disorders • Performing radionuclide therapies
Radiation therapy	Radiation therapists use focused beams of radiation to destroy tumours while minimizing harm to healthy tissues.	• Destroying cancerous tissue • Performing imaging procedures to support cancer treatment • Precisely targeting tumours for treatment • Using radioactive sources to directly treat cancer • Counselling patients on the possible side effects of radiation
Radiological technology	Radiological technologists use equipment that emits x-rays to produce images of body parts or systems. Those images are used by radiologists to advise treating physicians on diagnosis and treatment prescription.	• Taking x-ray images of chest, bones, joints or spine using plain film radiological technology • Detecting breast cancer in its earliest stages through mammography • Examining the heart, blood vessels and blood flow through angiography • Using fluoroscopy to produce real-time images showing the function of systems such as gastrointestinal or urinary • Producing detailed cross-sectional images of the body using computed tomography (CT scans)

MRTs can practise in disciplines in which they are certified. Based on data from Prince Edward Island, New Brunswick, Québec, Ontario, Manitoba, Saskatchewan, Alberta and the three territories, approximately one third of MRTs practise in radiological technology (34.4%), CT (11.8%), breast imaging (7.2%), bone mineral density (5.8%) and radiation therapy (6.7%) (CIHI, 2017). If certified in more than one area of practise, MRTs have the option of working in multiple areas, keeping one—the one associated with the greatest number of working hours—as their main area of practise.

In regulated jurisdictions, the exact scope and standards of practise are set by provincial regulatory bodies through legislation and, as a result, vary between jurisdictions. For example, while radiological technologists in Québec can perform both magnetic resonance examinations and sonography, in the rest of the country, these are considered separate programs.

CAMRT's description of practise in medical radiation technology includes a high-level overview of the professionalism, expertise and professional attributes required by MRTs to practise safely and effectively

Evidence and knowledge

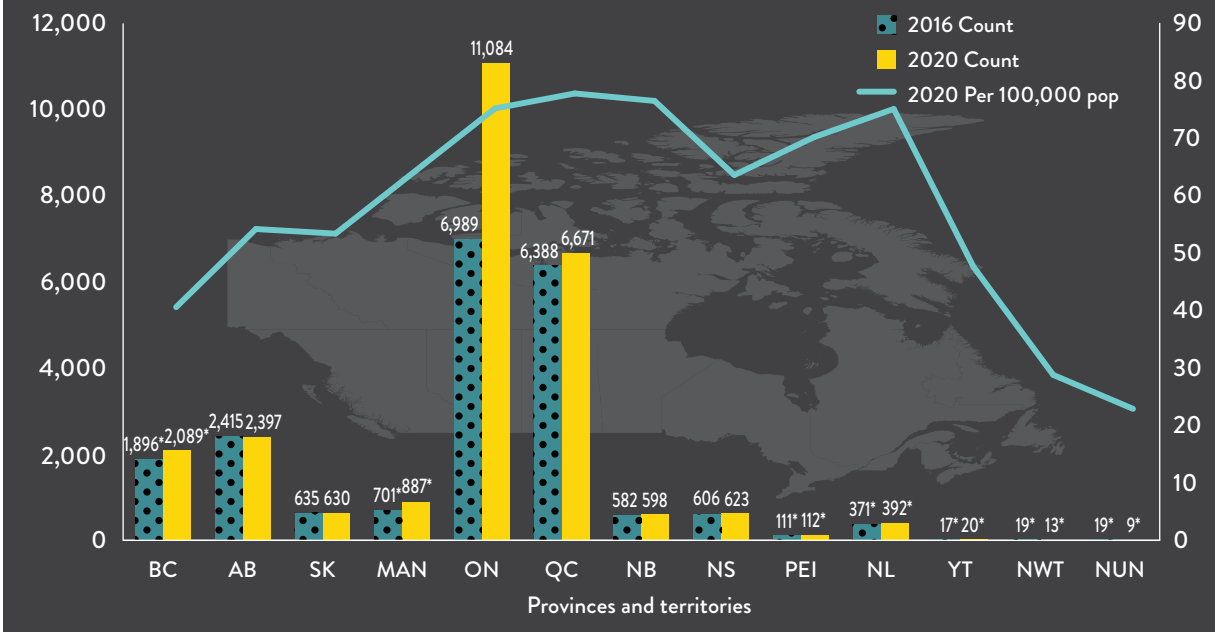
Research evidence is crucial to ensuring MRTs' knowledge is available and contributing to system evolution and change. The CAMRT has made it a priority to expand the culture of research and evidence in the medical radiation therapy profession in Canada, and supports MRTs by providing resources to help inform and educate other professionals about their key role in creating evidence and knowledge. At the same time, the CAMRT is working to support growth of the MRT contribution to the scientific commons.

(CAMRT, 2015). However, given that MRTs practise in many disciplines, including radiological technology, radiation therapy, nuclear medicine and magnetic resonance imaging, as well as many other sub-disciplinary specialities, the CAMRT description of practise does not include specifics (CAMRT, 2015).

Demographics

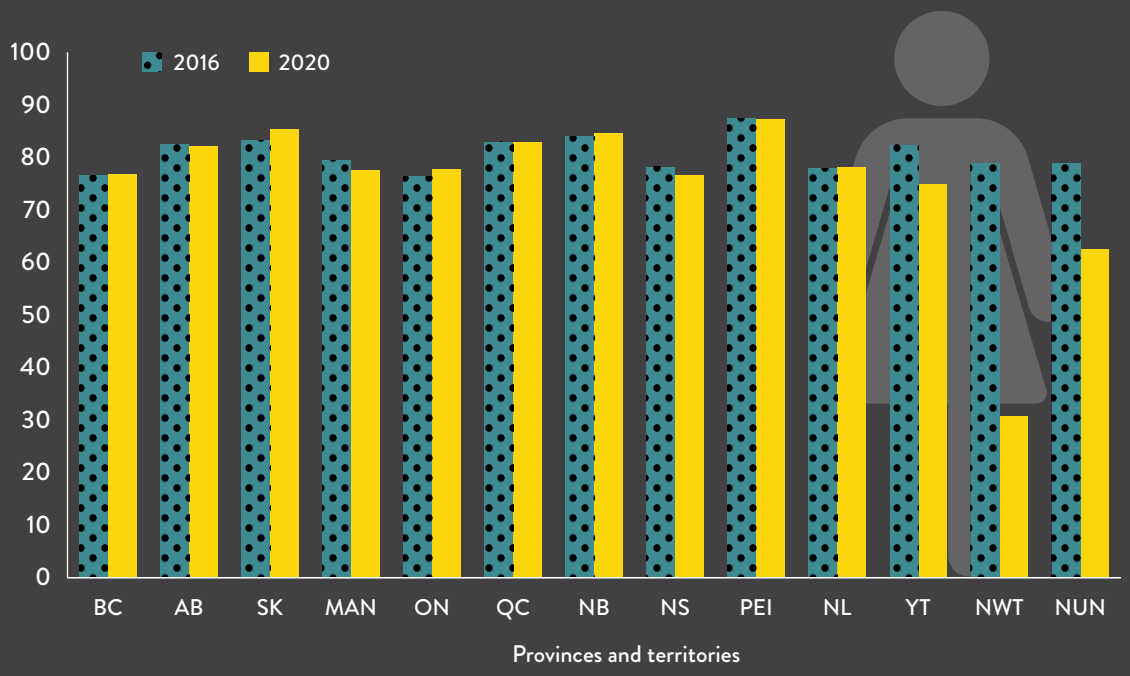
In 2020, there were 25,525 MRTs in Canada (CIHI, 2022). The MRT-to-population ratio was roughly 67 per 100,000 in that same year. Figure 3 highlights the number of MRTs per province/territory in and per population ratios Canada in 2020.

Figure 3: Medical radiation technologists—count and per population rates in Canadian provinces and territories, 2016 and 2020.



Source: Canadian Institute for Health Information, 2022, Health Workforce Database.
*Data for Ontario and the Territories are from 2017

Figure 4: Proportion of medical radiation technologists who identify as Women, by Canadian provinces and territories, 2016 and 2020



Source: Canadian Institute for Health Information, 2022, Health Workforce Database.

Gender distribution

As shown in Figure 4, the gender breakdown of MRTs shows that women predominate in the profession and that this has not changed very much over time. A report by CIHI found that that, on average, male MRTs tended to work longer hours than female MRTs (CIHI, 2017).

Age distribution

Figure 5, which presents the distribution of MRTs across Canada by age group in 2020, shows that the bulk of the MRT population is between the ages of 30 and 59.

Educational profile

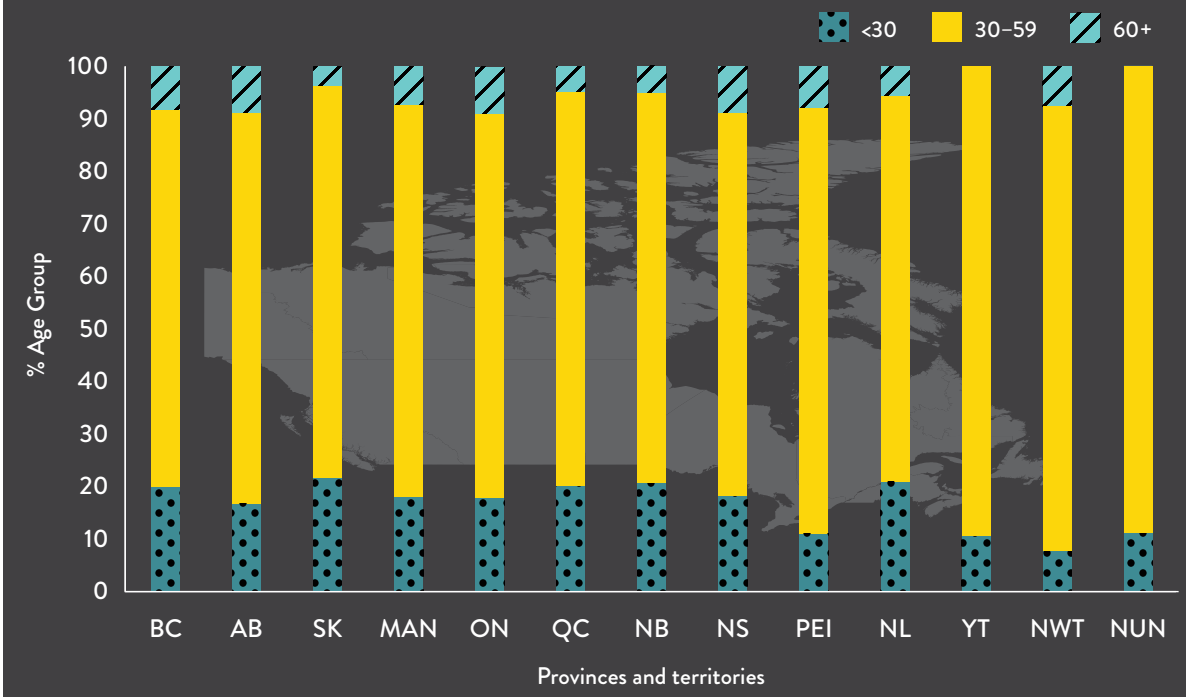
CIHI reported that in 2015, 88% of MRTs held a diploma as their basic level education for entry to practise (CIHI, 2017). Across the country, 41.4% of MRTs were newly graduated (within the past 10 years) (CIHI, 2017). Manitoba had the lowest percentage of newly graduated MRTs (34%) and Québec had the highest (50%) (CIHI, 2017). The majority of MRTs (95.3%) graduated from an MRT program in Canada (CIHI, 2017).

Of newly graduated MRTs in 2015, 34.4% obtained their initial CAMRT certification in radiological technology. Smaller proportions of graduates were educated in CT (11.8%) and breast imaging (7.2%) (CIHI, 2017).

Employment profile

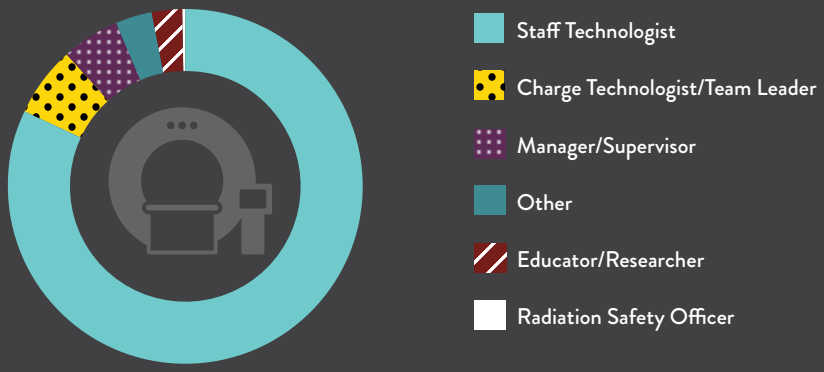
The majority (72.7%) of MRTs across Canada are full-time employees, while 27.3% held part-time positions in 2015 (CIHI, 2017). Figure 6 shows that, in 2015, most (83.1%) MRTs worked as staff technologists, including those working in hospitals, private clinics and cancer centres. The remainder were managers/supervisors (4.5%), charge technologists/team leaders (6.1%), radiation safety officers (0.2%) or educators/researchers (2.3%), or held other positions (3.8%) (CIHI, 2017).

Figure 5: Age distribution of medical radiation technologists, by Canadian provinces and territories, 2016 and 2020



Source: Canadian Institute for Health Information, 2022, Health Workforce Database.

Figure 6: Distribution of MRTs by position, 2015



Source: Canadian Institute for Health Information. (2017). *Medical radiation technologists, 2015.*
In 2015, the majority (91.1%) of MRTs worked in positions providing diagnostic and therapeutic services directly to patients (CIHI, 2017).

Table 4 shows the breakdown of MRTs according to their major functions.

TABLE 4: Distribution of MRTs by major function, 2015

Major Function	Count	Percentage
Diagnostic and therapeutic services	8,410	91.1%
Administration	360	3.9%
Other major function	460	5.0%
TOTAL	**9,230**	**100%**

Source: Canadian Institute for Health Information. (2017). Medical radiation technologists, 2015.

*Data available only for Ontario, Manitoba, Saskatchewan and Alberta.

The percentage of MRTs working in hospital settings ranged from 55.7% in Alberta to 95.7% in New Brunswick. This wide range represents the different organizational structures and unique ways of delivering medical imaging services across the jurisdictions (CIHI, 2017). Other work settings included free-standing imaging facilities/clinics (14.4%), cancer care centres (6.2%), community health centres (1.3%) and others (3.0%) (CIHI, 2017).

Access to quality care in Indigenous communities

As technology, knowledge and capabilities evolve, what was once the standard of care can become obsolete. Given this reality, it is vitally important to ensure all Canadians can access care that reflects current standards.

Discrepancies and deficits in care can exist anywhere, as new standards and practises are adopted at varying rates across the country, but they are generally most pronounced in remote and Indigenous communities. As part of CAMRT's commitment to the Truth and Reconciliation Commission report, it is working with Indigenous health organizations and Health Canada to develop strategies to provide Indigenous communities with access to diagnostic services.

Coverage of Services and Remuneration

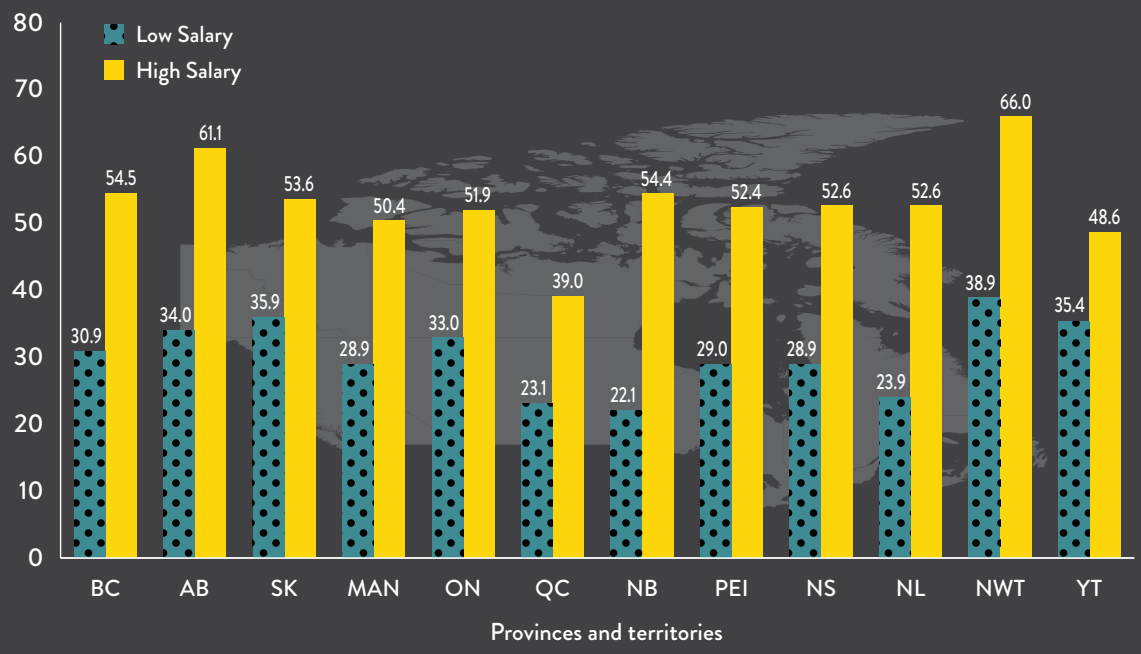
Most medical imaging and radiation therapy procedures are publicly funded, with costs generally covered though provincial and territorial health insurance plans. Some provinces allow for private clinics with differing payment or reimbursement models ranging from fully government-supported programs to fee-for-service access to medical imaging services.

Salary

According to Living in Canada (2022), employment prospects for MRTs are very good in Canada and will continue to improve. As the population ages and new medical technologies and techniques are developed, more MRTs will be required.

The typical salary for a full-time MRT in Canada is between $60,000 and $80,000 per year in 2018/19. MRTs in Alberta earn the highest hourly average wage of $41.14, and MRTs in Montréal earn the lowest average wage of $31.00 per hour (Living in Canada, 2022). Figure 7 shows the range of hourly wages for MRTs in various provinces and territories.

Figure 7: High and low hourly wages for MRTs in Canada



Source: CAMRT. Salary scale analysis. Retrieved [2019] from https://www.camrt.ca/mrt-profession/professional-resources/salary-scale-analysis

Impact of COVID-19 on the profession

The Canadian Association of Medical Radiation Technologists administered a survey to members and discovered that more than a third of Medical Radiation Technologists (MRTs) reported not having access to appropriate personal protective equipment (PPE), and a majority of those felt they had lesser access to PPE than other health care workers in their institutions.[1] The pandemic highlighted the widespread lack of awareness for the MRT professions and their duties, especially among decision-makers in governments and health-care institutions.

In 2021, a National Mental Health Survey was conducted to gauge the mental health of Canadian MRTs in the context of their work during the COVID-19 pandemic. The results revealed a substantial burden on MRTs, including:

- 60% of MRTs reported they had too much work to do everything well
- 64% of MRTs reported high levels of emotional exhaustion
- Nearly 8 times more MRTs experienced severe mental illness as compared to 2018 results[2]

As MRTs continue to suffer from pandemic burnout, staffing shortages and growing patient wait lists, advocating for change at the individual, organization and systems level is crucial. Longer-term solutions are needed to support the healthcare profession, such as greater funding to support achieving a fair and equitable workload balance, greater access to mental health services, and an increase in human resources to improve the sustainability of the MRT profession moving forward.

1 Canadian Association of Medical Radiation Technologists. (2020, April). *Personal protective equipment for MRTs during the COVID-19 crisis*. https://www.camrt.ca/wp-content/uploads/2020/04/PPE-Survey-Results-MRTs-during-the-COVID-19-Crisis.pdf

2 Canadian Association of Medical Radiation Technologists. (2021, May). *The mental health of medical radiation technologists in Canada*. https://www.camrt.ca/wp-content/uploads/2021/10/CAMRT-National-Mental-Health-Survey-2021.pdf

Conclusion

In the 120 years since the discovery of x-rays, technology advancements have made medical radiation technology a continuously evolving field. Today, medical imaging and radiation therapy are indispensable components of the healthcare system. MRTs operate diagnostic-imaging and radiation-therapy equipment to produce images of body structure and function and administer radiation treatment to diagnose and treat injury and disease, making them integral members of the healthcare team with a significant impact on patient care.

Acknowledgements

Parts of this material are based on data and information provided by the Canadian Institute for Health Information. However, the analyses, conclusions, opinions and statements expressed herein are those of the author and not necessarily those of the Canadian Institute for Health Information.

Acronyms

CAMRT	Canadian Association of Medical Radiation Technologists
CT	Computed tomography
IEMRT	Internationally educated medical radiation technologist
MRI	Magnetic resonance imaging
MRT	Medical radiation technologist

Additional Resources

Canada

Canadian Association of
Medical Radiation Technologists
www.camrt.ca

Alberta

Alberta College of Medical Diagnostic
and Therapeutic Technologists
www.acmdtt.com

British Columbia

Canadian Association of Medical Radiation
Technologists – British Columbia
www.camrt.ca/BC

CAMRT ATL

CAMRT Atlantic provides association services for
NS, NB, PEI and NL
www.camrt.ca/atlantic/

Manitoba

Manitoba Association of
Medical Radiation Technologists
www.mamrt.ca

New Brunswick

New Brunswick Association of
Medical Radiation Technologists
www.nbamrt.ca

Newfoundland and Labrador

CAMRT-ATL (Newfoundland & Labrador)
www.camrt.ca/atlantic/nl/

Nova Scotia

Nova Scotia College of Medical Imaging and Radiation
Therapy Professionals
www.nscmirtp.ca/

Ontario

Ontario Association of Medical Radiation Sciences
www.oamrs.org

Prince Edward Island

College of Allied Health Professional of
Prince Edward Island
www.cahppei.ca/

Québec

Ordre des technologues en imagerie médicale,
en radio-oncologie, et en électrophysiologie
médicale du Québec
www.otimroepmq.ca

Saskatchewan

Saskatchewan Association of
Medical Radiation Technologists
www.samrtonline.ca

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