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*Interprofessional Collaboration*

**Scope of Practice Review:  
Medical Radiation Technology**

**Summary & Selected Highlights from the  
Literature**

**October 2008**

## Background

In June 2007, the Minister of Health and Long-Term Care (the Minister) requested the Health Professions Regulatory Advisory Council (HPRAC) to:

*Recommend mechanisms to facilitate and support interprofessional collaboration between health Colleges, beginning with the development of standards of practice and professional practice guidelines where regulated professions share the same or similar controlled acts, acknowledging that individual health Colleges independently govern their professions and establish the competencies for their profession.*<sup>1</sup>

In the course of preparing an interim report to the Minister, in conjunction with its review of the scope of practice of nurse practitioners, HPRAC and the Ministry determined that it was necessary to include scope of practice reviews of six professions – dietetics, midwifery, pharmacy, physiotherapy, medical laboratory technology and medical radiation technology within the context of the advice that was requested regarding interprofessional collaboration. These reviews were to be undertaken within the context of the Minister’s request for advice on facilitating and supporting interprofessional collaboration among Colleges. Advice on the first four of these professions is complete and has been delivered to the Minister.

These reviews are being undertaken in the context of a broader review requested by the Minister of Health and Long-Term Care to explore opportunities to advance interprofessional collaboration across regulated health professions. It includes a review of scopes of practice for a number of health professions that are most directly involved in interprofessional care to ensure that there are no legislative, regulatory, structural or process barriers to members of the professions working to the maximum of their scope of practice or to working in interprofessional settings or collaborative teams.

In Ontario, the legislative framework that defines health professions’ scope of practice includes the *Regulated Health Professions Act, 1991 (RHPA)* and a series of profession-specific Acts. The *RHPA* contains provisions with respect to the duties and powers of the Minister, the role of HPRAC, a list of controlled acts and other statutory requirements. It also includes a procedural code governing the operation of regulatory colleges.

Each profession-specific Act includes a scope of practice statement. The scope of practice statement in the *Medical Radiation Technology Act, 1991* states that:

*The practice of medical radiation technology is the use of ionizing radiation and other forms of energy prescribed under subsection 12 (2) to produce diagnostic images and tests, the evaluation of the technical sufficiency of the images and tests, and the therapeutic application of ionizing radiation.*<sup>2</sup>

The scope of practice statement found in each health profession act provides a generic frame of reference (or parameters) for the practice of each regulated health profession. A regulated health professional may perform his or her profession’s authorized acts only in the course of practising

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<sup>1</sup> Letter from the Minister of Health and Long-Term Care to HPRAC. June 2007. [http://www.hprac.org/en/reports/resources/HPRACletterJune28\\_2007.pdf](http://www.hprac.org/en/reports/resources/HPRACletterJune28_2007.pdf)

<sup>2</sup> *Medical Radiation Technology Act, 1991*. [http://www.e-laws.gov.on.ca/html/statutes/english/elaws\\_statutes\\_91m29\\_e.htm](http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_91m29_e.htm)

within the profession's scope of practice. However, this statutory scope of practice statement is only one element of a profession's scope of practice. Each profession-specific Act also indicates any controlled acts the profession is authorized to perform, the title or titles restricted to members of the profession and other provisions.

Accordingly, as part of its review of a professional scope of practice, HPRAC<sup>3</sup>:

- analyzes the scope of practice statement and the controlled acts authorized to the profession;
- considers the implications of the harm clause contained in the *RHPA* (which prohibits everyone except health professionals acting within their scope of practice from treating or giving advice with respect to health where serious physical harm may result);<sup>4</sup>
- considers regulations developed under the profession-specific Act and other legislation that may affect the profession; and
- reviews the standards of practice, guidelines, policies and by-laws developed by the regulatory college.

Collectively, these elements determine the profession's scope of practice and therefore have been considered by HPRAC in its review of the scope of practice for medical radiation technology.

The profession of medical radiation technology was invited to submit recommendations articulating proposed changes required to their scope of practice to enhance interprofessional collaboration and assist members in working to the maximum of their scope of practice. The College of Medical Radiation Technologists of Ontario (CMRTO), in collaboration with the Ontario Association of Medical Radiation Technologists (OAMRT), submitted its response to HPRAC's *Applicant Questionnaire* respecting the scope of practice review for medical radiation technology in June 2008. The submission is available on HPRAC's website.<sup>5</sup>

In addition to requesting access to additional controlled acts, the College of Medical Radiation Technologists of Ontario and the Ontario Association of Medical Radiation Technologists have proposed to amend the profession's scope of practice statement as follows:

*The practice of medical radiation technology is the use of ionizing radiation, electromagnetism and other forms of energy prescribed under subsection 12(2) for the purpose of diagnostic and therapeutic procedures, the evaluation of images and data related to the procedure and the assessment of the condition of an individual before, during and after the procedure.*<sup>6</sup>

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<sup>3</sup> See criteria. Review of a Professional Scope of Practice under the *Regulated Health Professions Act*. Health Professions Regulatory Advisory Council. May 2007.

[http://www.hprac.org/en/reports/resources/Scope\\_of\\_Practice\\_June\\_12\\_2007.pdf](http://www.hprac.org/en/reports/resources/Scope_of_Practice_June_12_2007.pdf)

<sup>4</sup> s.30 Effective June 4, 2009, or on an earlier day to be established by proclamation, this section will be amended by striking out "physical" and substituting "bodily". See *Health System Improvements Act, 2007*, S.O. 2007, c.10, Sched.M, ss.6 and 75 (1).

<sup>5</sup> [http://hprac.org/en/projects/Medical\\_Radiation\\_Technology\\_Scope\\_of\\_Practice.asp](http://hprac.org/en/projects/Medical_Radiation_Technology_Scope_of_Practice.asp)

<sup>6</sup> CMRTO and OAMRT. Request for Change in Scope of Practice – Medical Radiation Technology. Submitted to HPRAC June 30, 2008. p.5 .

<http://hprac.org/en/projects/resources/CollegeofMedicalRadiationTechnologistsOfOntarioSubmission.pdf>

HPRAC has established 10 criteria that it considers in reviewing a profession's scope of practice.<sup>7</sup>

### **Purpose, Approach & Format of the Paper**

This paper summarizes some of the recent literature on Medical Radiation Technology practice (also known as Radiography) as it relates to the scope of practice changes being proposed by the profession. It is not intended to represent an exhaustive review of the literature; rather, it focuses on identifying key documents that may help to inform discussions about and considerations of the scope of practice review for Medical Radiation Technology in Ontario.

The literature reviewed in this paper should be examined in conjunction with documents highlighted in a previous literature review completed by HPRAC in January 2008.<sup>8</sup> That review looked at interprofessional collaboration with respect to the legislative, regulatory, policy and structural/organizational issues that can facilitate and support health regulatory colleges and their members in advancing collaborative practice.

The literature included in the medical radiation technology review comes from diverse sources. Initial reference documents were included in the submission to HPRAC by *The College of Medical Radiation Technologists of Ontario* (June 30, 2008).<sup>9</sup> Additional literature sources were identified through a literature search focused on the following terms:

- “scope of practice medical radiation technology[/radiography]” - “scope of practice medical radiation technologists [/radiographers]” –
- “medical radiation technology [/radiography] and scope of practice”
- “medical radiation technology and interprofessional” –
- “medical radiation technologists and collaboration” “medical radiation technology [/radiography] and advanced practice” –
- “medical radiation technology [/radiography] and ALARA” –
- “radiog\* and digital imaging”.

Regulatory-related articles using *PubMed Search* were also reviewed. In addition, supplementary searches were undertaken to identify specific reports from government websites, medical radiation technology/radiography associations, and health policy think tanks in an attempt to locate studies related to regulation and medical radiation technology scope of practice as identified in some of the literature reviewed. Some of these searches were successful, others were not.

The literature included as part of this review has been organized as follows:

- Section 1 summarizes the highlights and key findings arising from the literature.

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<sup>7</sup> See Review of a Professional Scope of Practice under the *Regulated Health Professions Act*. [http://www.hprac.org/en/reports/resources/Scope\\_of\\_Practice\\_June\\_12\\_2007.pdf](http://www.hprac.org/en/reports/resources/Scope_of_Practice_June_12_2007.pdf)

<sup>8</sup> See [www.hprac.org](http://www.hprac.org) for the full copy of the literature review: HPRAC. Interprofessional Regulatory Collaboration – A summary of key reference documents and selected highlights from the literature. January 2008.

<sup>9</sup> CMRTO and OAMRT. Request for Change in Scope of Practice – Medical Radiation Technology. Submitted to HPRAC June 30, 2008.

- Section 2 summarizes the documents reviewed organized under the following three themes: scope of practice; health system changes/trends; and patient safety/risk of harm.

## Section 1: Key Findings Arising From the Literature

There is a paucity of literature related specifically to issues concerning MRT scope of practice. The United Kingdom has undertaken some research in this area indicating that the roles of radiographers have changed significantly with new roles and responsibilities emerging in response to rapid innovations unfolding in the field of radiology and diagnostic imaging (DI).

The lack of published literature related to MRT scope of practice has been offset by an abundance of literature emerging on issues related to the dramatic changes unfolding in the field of DI; barriers to access; human resources shortages; and escalating costs associated with DI. Growing concern about these issues have prompted governments at both the provincial and federal level to establish a number of special committees/task forces focused on reviewing how diagnostic imaging services are currently provided to patients, how these services are presently managed and how to improve monitoring of quality, access and costs associated with these services.

In Ontario, for example, The Institute for Clinical and Evaluative Sciences (ICES) undertook a recent review of these issues in response to a request by the Diagnostic Services Committee.<sup>10</sup> A key priority was to establish strategic goals and directions for Ontario's diagnostic services system. A descriptive analysis of the utilization of diagnostic services in Ontario and a review of the management of these services in a number of selected jurisdictions was undertaken. The ICES report focused on DI technologies given that they comprise the majority of technologically advanced, high cost and rapidly growing diagnostic services in Ontario. (Laboratory and pathology services as well as genetic testing were excluded.) Some of the policy recommendations emerging from the review correlate strongly with issues that need to be considered with respect to enhanced scope of practice for MRTs. Some of the relevant recommendations emerging from the ICES report include:

- Consultation with national and international organizations to develop a standard and comprehensive method for recording and reporting diagnostic service utilization and cost; attention to the cost of diagnostic imaging tests themselves as well as to downstream savings and costs is required.
- Adoption of a universal, province-wide, web-based system for ordering diagnostic imaging tests to allow clinicians to access the results of previous imaging tests and thus decrease the frequency of unnecessary repeat testing. Until such a system is adopted, targeted chart reviews could prove useful for identifying areas where appropriateness of testing may be a concern.
- A population-based study that seeks to understand the relationship between the intensity of diagnostic imaging use and health outcomes in Ontario is necessary in order to fully understand reports from the US Medicare population which suggest that higher spending for diagnostic imaging does not lead to improved health outcomes.
- Investment in education related to diagnostic services on several fronts including: the public, medical school students and residents, continuing medical education (CME), diagnostic imaging ordering systems that embed clinical practice guidelines (e.g., web-based computer order entry systems), as well as continuous audit and feedback of performance to clinicians.

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<sup>10</sup> The Diagnostic Services Committee (DSC), with representation from the Ontario Medical Association, the Ontario Hospital Association, and the Ontario Ministry of Health and Long-Term Care (MOHLTC), was established through the Physician Services Framework Agreement to provide advice to the Minister of Health and Long-Term Care on the planning and coordination of the diagnostic services system in Ontario. See Institute for Clinical and Evaluative Sciences. Diagnostic Services in Ontario: Descriptive Analysis and Jurisdictional Review. April 2007 (revised). [http://www.ices.on.ca/file/Diagnostic\\_Services\\_Ontario\\_Oct16.pdf](http://www.ices.on.ca/file/Diagnostic_Services_Ontario_Oct16.pdf)

- Continued support for the Ontario Health Technology Assessment Committee (OHTAC), particularly for its recent and unique role in recommending field studies relating to diagnostic imaging technology. An application for OHTAC to examine obsolete and substitution diagnostic imaging technologies should be submitted.
- Trends in the ambulatory provision of imaging services by non-radiologists should be monitored, and key stakeholders should be involved in the creation of clear guidelines regarding self-referral for diagnostic imaging.

The review of the literature also revealed a strong base of research evaluating the film reading performance of different health care professionals. While there are numerous studies describing this issue for different types of testing (and in different health settings), there is a lack of evidence of the subsequent effects on the referring clinician's diagnosis, management plans and patient outcome.

An emerging issue being reviewed in the literature relates to concerns about the lack of understanding of the role of imaging in specific clinical circumstances that is leading to unnecessary imaging and/or imaging perceived as being “inappropriate” in terms of timing or the choice of modality. Recently, this body of research has focused on the increasing costs associated with diagnostic testing and the need for the development of practical, sustainable means to improve the appropriateness of testing. Understanding how to develop and disseminate sophisticated decision-analysis models, the role of point-of-care guidance and feedback systems, and effective clinical change-management strategies are particular issues identified for further study in the literature.

A summary of some of the highlights emerging from the literature reviewed are summarized below.

### **Overview: Medical Radiation Technologists**

- ***Medical Radiation Technologists (MRTs) practice in radiological technology, radiation therapy, nuclear medicine or magnetic resonance imaging. MRTs make up the majority of the medical imaging workforce in Canada.*** Approximately three quarters of all MRTs are radiologic technologists.<sup>11</sup>
- ***Basic X-ray and ultrasound account for nearly 80 per cent of all medical imaging examinations in Canadian hospitals.***<sup>12</sup>
- ***Access to diagnostic equipment and human resources are impeding early diagnoses and inhibiting high quality treatment for patients in some parts of the country.***<sup>13</sup> In particular, there are high MRT vacancy rates across Canada in a number of areas particularly for radiological technologists and magnetic resonance technologists. Workforce shortages contribute to increased patient wait times, cancelled procedures, decreased patient satisfaction, plans to stop offering a specific service, etc.<sup>14</sup>

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<sup>11</sup> Canadian Institute for Health Information. Medical Imaging in Canada, 2007. Ottawa. 2008.

<sup>12</sup> Ibid.

<sup>13</sup> Canadian Association of Radiologists. Vision 2000: Medical Imaging Services in Canada. In partnership with Organized Radiology – Canadian Heads of Academic Radiology and the Medical Imaging Industry. 2000.

<sup>14</sup> Canadian Association of Medical Radiation Technologists. Supply and Demand Study of Utilization of Medical Radiation Technologists in Canada. September 2006.

- **Human resource shortages of MRTs across Canada are expected to increase in response to a number of health system trends (e.g., aging workforce, rapidly changing technology and innovation in the field of diagnostics, and a predominantly female workforce).**<sup>15</sup>

### Scope of Practice

- **MRTs are responding to changes in care delivery that are emerging largely from the rapid pace of change and innovation in the field of DI.** Over the past decade, the scope of practice for radiographers has been enhanced in response to changing health care needs and rapid innovations emerging in the field. MRTs now undertake new responsibilities in every area of diagnostic imaging and radiotherapy.<sup>16</sup>
- **Human resource shortages and increased demand are driving the need to look at how MRTs services are delivered and by whom.** The United Kingdom stands out as a leader in studying and implementing expanded roles for MRTs. The radiography profession in this jurisdiction has been proactive in challenging the scope of clinical practice.<sup>17</sup>
- **Lessons learned from the United Kingdom's experience with GI radiographers have the potential to be transferred to the Radiology Assistant (RA) role recently introduced in the United States and enhanced scopes of practice being considered in other jurisdictions.** The RA role has the potential to be of benefit to the profession and patients.<sup>18</sup>
- **Role expansion in radiography is linked to ethico-legal responsibilities and accountability.** Role developments require new rules and standards including clarification of legal requirements and professional guidelines.<sup>19</sup>
- **The level of education required to work in medical imaging varies from profession to profession.** For example, it may take from two to four years to become a magnetic resonance imaging technologist following high school graduation. For paediatric radiology physicians and neuroradiology physicians, training may take 14 years.<sup>20</sup>

### Health System Changes/Trends

- **Future advances in computer technology, coupled with an increase in the accuracy and sensitivity of imaging technologies, will make it possible to seamlessly integrate diagnosis and treatment.** Future image-guided interventions will also enable medical practitioners to

<sup>15</sup> Canadian Association of Medical Radiation Technologists. Supply and Demand Study of Utilization of Medical Radiation Technologists in Canada. September 2006.

<sup>16</sup> College of Radiographers [United Kingdom]. Role Development Revisited: The Research Evidence 2003. *Radiography*. 2003; Hawnaur, Jane. Diagnostic Radiology. *British Medical Journal*. Vol 319. 368-171. 1999; Price, R.C. and Le Masurier, S.B. Longitudinal changes in extended roles in radiography: A new perspective. *Radiography*. Vol 13. 18-29. 2007.

<sup>17</sup> See, for example: College of Radiographers [United Kingdom]. Role Development Revisited: The Research Evidence 2003. *Radiography*. 2003; Hardy, M. and Snaith, B. Role Extension and Role Advancement – Is There a Difference? *Radiography*. Vol 12. 327-331. 2006; Hogg, Peter. Advanced Clinical Practice for Radiographers in Great Britain: Professional Roles, Accountability and the Educational Provision. *The Canadian Journal of Medical Radiation Technology*. Vol 35:4. Winter 2004.

<sup>18</sup> Nightingale, Julie and Hogg, P. The Role of a GI Radiographer: A United Kingdom Perspective. *Radiologic Technology*. March-April 2007.

<sup>19</sup> White, P. and MacKay, J.C. Guidelines and Legal Requirements Which Inform Role Expansion in Radiography. *Radiography*. Vol 8. 71-78. 2002.

<sup>20</sup> Canadian Institute for Health Information. Medical Imaging in Canada, 2007. Ottawa. 2008.

detect critical illnesses at their most curable. These trends will shift the practice of medicine from one of disease detection and treatment to one of prediction and prevention in asymptomatic, at-risk populations.<sup>21</sup>

- ***The demand and need for Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) is rapidly increasing. However, there are signs of over-reliance (and inappropriate use) of technology and DI.*** Inappropriate imaging is a threat to effective diagnosis and effective allocation of resources. The development and dissemination of knowledge-based clinical guidelines (and other decision support systems) is one strategy currently being advocated to reduce inappropriate imaging.<sup>22</sup>
- ***New technologies have significant impacts on clinical practices. The impacts need to be better understood, particularly in terms of outcomes and productivity.***<sup>23</sup>
- ***Radiology has participated in the recent trend towards computerised management in the health system and has responded to the demand for cost-efficient and rapid communication between departments of radiology and their users.***<sup>24</sup>

### **Patient Safety/ Risk of Harm**

- ***There is evidence that radiographers can successfully undertake high quality diagnostic reporting for some X-rays and plain radiographs (e.g., nuclear medicine departments, barium enemas) thereby alleviating time pressures and demands on radiologists.*** However, despite the growing number of studies that evaluate the film reading performance of different health care professionals, there is a paucity of evidence tracking and reporting on the subsequent effects on the referring clinician's diagnosis, management plans and patient outcomes.<sup>25</sup>
- ***Physicians and other health practitioners are insufficiently aware of the long term health risks associated with radiological imaging. These risks are often ignored in cost effectiveness analyses of medical imaging.*** Patients are not being given information about the risks, benefits, and radiation dose for diagnostic imaging tests and CT scans. Patients, ED

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<sup>21</sup> National Institutes of Health. Image Guided Interventions. Department of Health and Human Services, USA. September 2006.

<sup>22</sup> 2006 Annual Report of the Office of the Auditor General of Ontario: 3.06 Hospitals – Management and Use of Diagnostic Imaging Equipment; Glaves, J. The Use of Radiological Guidelines to achieve a sustained reduction in the number of radiographic examinations of the cervical spine, lumbar spine and knees performed for GPs. *Clinical Radiology*. Vol 60. 914-920. 2005; Picano, E. Sustainability of medical imaging: doctors and patients should be more aware of the long term risks of radiological investigations. *British Medical Journal*. Vol 328. 2004.

<sup>23</sup> Hawnaur, Jane. Diagnostic Radiology. *British Medical Journal*. Vol 319. 368-171. 1999.

<sup>24</sup> Ibid.; National Institutes of Health. Image Guided Interventions. Department of Health and Human Services, USA. September 2006.

<sup>25</sup> Brealy, S. et al. Radiographers and Radiologists Reporting Plain Radiograph Requests from Accident and Emergency and General Practice. *Clinical Radiology*. Vol 60. 710-717. 2005; Brealey, S.D. and Scuffham, P.A. The effect of introducing radiographer reporting on the availability of reports for Accident and Emergency and General Practitioner examinations: a time-series analysis. *The British Journal of Radiology*. Vol 78. 538-542. 2005; Elliot, L. Radiographer reporting in the nuclear medicine department: a learning curve? *Radiography*. Vol 9:247-251. 2003; Murphy, M. et al. A Comparison of Radiographer and Radiologist Reports on Radiographer Conducted Barium Enemas. *Radiography*. Vol: 8. 215-221. 2002; Robinson, P.J.A. et al. Interpretation of Selected Accident and Emergency Radiographic Examinations by Radiographers: A Review of 11000 Cases. *The British Journal of Radiography*. Vol 72. 546-551. 1999.

physicians, and radiologists are unable to provide accurate estimates of CT doses regardless of their experience level.<sup>26</sup>

- ***Awareness of radiation protection issues is generally low, with widespread underestimation of relative doses and risks.*** There is a growing body of research emerging on this issue.<sup>27</sup>

### **Future Priorities: Challenges & Opportunities**

- The literature identifies the following as specific areas where future research is required:
  - Training, education and research to support the changing scope of practice including establishment of guidelines to ensure MRTs have appropriate skills and knowledge.<sup>28</sup>
  - Mechanisms to monitor and control the adoption/use of expensive, emerging technology.<sup>29</sup>
  - Web-based and other electronic tools for the management of test results to support clinical decision-making, improve timely access and avoid costly duplication.<sup>30</sup>
  - Collection of regular supply and demand information for MRTs in Canada to inform HR planning and forecasting.<sup>31</sup>
  - Radiological awareness of long-term health risks associated with radiological imaging by auditing prescriptions and more explicit informed consent forms.<sup>32</sup>

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<sup>26</sup> Lee, C. et al. Diagnostic CT Scans: Assessment of Patient, Physician, and Radiologist Awareness in Radiation Dose and Possible Risks. *Radiology*. Vol 231: 393-298. 2004; McCollough, C. et al. CT Dose Reduction and Dose Management Tools: Overview of Available Options. *Radiographics*. Vol 26:2. March-April 2006.

<sup>27</sup> Shiralkar, S. et al. Doctor's Knowledge of Radiation Exposure: Questionnaire Study. *British Medical Journal*. Vol 327. 371-372. 2003; Thomas, K. et al. Assessment of Radiation Dose Awareness Among Paediatricians. *Paediatric Radiology*. Vol 36. 823-832. 2006.

<sup>28</sup> Brealey, Stephen. Measuring the Effects of Image Interpretation: An Evaluative Framework. *Clinical Radiology*. Vol 56. 2001.

<sup>29</sup> Institute for Clinical and Evaluative Sciences. Diagnostic Services in Ontario: Descriptive Analysis and Jurisdictional Review. April 2007 (revised).

<sup>29</sup> Canadian Association of Medical Radiation Technologists. Supply and Demand Study of Utilization of Medical Radiation Technologists in Canada. September 2006.

<sup>30</sup> Bairstow, P.J. et al. Diagnostic Imaging Pathways: Development, Dissemination, Implementation and Evaluation. *International Journal for Quality in Health Care*. Vol 18:1. 51-57. 2005; Institute for Clinical and Evaluative Sciences. Diagnostic Services in Ontario: Descriptive Analysis and Jurisdictional Review. April 2007 (revised).

<sup>31</sup> Canadian Association of Medical Radiation Technologists. Supply and Demand Study of Utilization of Medical Radiation Technologists in Canada. September 2006.

<sup>32</sup> Picano, E. Sustainability of medical imaging: doctors and patients should be more aware of the long term risks of radiological investigations. *British Medical Journal*. Vol 328. 2004.

## Section 2: Summary of the Literature

### Scope of Practice

Authors, Title and Publication	Context/Type of Document	Main Findings/Recommendations
<p>American College of Radiology. American College of Radiology White Paper on MR Safety: 2004 Update and Revisions. <i>American Journal of Radiology</i>. Vol 182, May 2004.</p>	<p>Report of the American College of Radiology (ACR) Blue Ribbon Panel on MR Safety.</p>	<p>Discusses potential risks related to MR not only for the patient but also for the attending health care professionals, accompanying family members, and others who may find themselves in the magnetic fields of MR scanners.</p> <p>New topics addressed in the White Paper:</p> <ul style="list-style-type: none"> <li>▪ Drug delivery patches/pads</li> <li>▪ Paediatric MR safety</li> <li>▪ Foetal MR contrast agent safety concerns</li> <li>▪ MR scanning of patients in whom there are/may be cardiac pacemakers and/or implanted cardioverter defibrillators (icds).</li> </ul>
<p>American College of Radiology and American Society of Radiologic Technologists. Registered Radiologist Assistant: Role Delineation. January 2005.</p>	<p>A consensus statement developed by the American College of Radiology (ACR) and the American Society of Radiologic Technologists (ASRT). The statement proposes that the R.R.A. is an advanced-level radiographer who works under the supervision of a radiologist to promote high standards of patient care by assisting radiologists in the diagnostic imaging environment. Under radiologist supervision, the R.R.A. performs patient assessment, patient management, and selected clinical imaging procedures. Certification as an R.R.A. does not qualify the R.R.A. to perform interpretations (preliminary, final, or otherwise) of any radiological examination.</p>	<p>The American Registry of Radiologic Technologists (ARRT) proposed development of a certification program for a new level of imaging technologist called the Registered Radiologist Assistant (R.R.A.). The R.R.A. will be certified and registered in radiography by ARRT and, in addition, will have met the educational, ethics, and examination standards established by ARRT for certification and registration as an R.R.A.</p> <p>This R.R.A. Role Delineation was developed as a vision of what can be created through the establishment of structured educational programs, selection of appropriately qualified and experienced radiographers, implementation of a certification mechanism, modification of existing regulations, and acceptance by the professional community. The vision is based on the belief that establishment of a new level of imaging technologist supervised by radiologists will enhance access for patients to high-quality radiology services.</p>
<p>Brealy, S. et al. Radiographers and Radiologists Reporting Plain Radiograph Requests from Accident and Emergency and General Practice. <i>Clinical Radiology</i>. Vol 60. 710-717. 2005.</p>	<p>This article assesses selectively trained radiographers and consultant radiologists reporting plain radiographs for the Accident and Emergency Department (A&amp;E) and general practitioners (GPs) within a typical hospital setting.</p> <p>Results of a retrospectively selected, random, stratified sample of 400 A&amp;E and 400 GP plain radiographs. An independent consultant radiologist judged whether the radiographer and radiologist reports agreed with the reference standard report. Clinicians then assessed whether</p>	<p>For A&amp;E and GP plain radiographs, respectively, there was a 1% and 4% difference in reporting accuracy between the two professional groups. For both A&amp;E and GP cases there was an 8% difference in the clinicians' confidence in their diagnosis based on radiographer or radiologist incorrect reports. For A&amp;E and GP cases, respectively, there was a 2% and 8% difference in the clinicians' confidence in their management plans based on radiographer or radiologist incorrect reports. For A&amp;E and GP cases, respectively, there was a 1% and 11% difference in effect on patient outcome of radiographer or radiologist incorrect reports.</p> <p>There is the potential to extend the reporting role of selectively trained radiographers to include plain radiographs for all A&amp;E and GP patients.</p>

	radiographer and radiologist incorrect reports affected confidence in their diagnosis and treatment plans, and patient outcome.	Further research conducted during clinical practice at a number of sites is recommended.
Brealey, S.D. and Scuffham, P.A. The effect of introducing radiographer reporting on the availability of reports for Accident and Emergency and General Practitioner examinations: a time-series analysis. <i>The British Journal of Radiology</i> . Vol 78. 538-542. 2005.	This study explores whether the introduction of selectively trained radiographers reporting Accident and Emergency (A&E) X-ray examinations of the appendicular skeleton affected the availability of reports for A&E and General Practitioner (GP) examinations at a typical district general hospital. Monthly data on A&E and GP examinations for 1993–1997 was analyzed using structural time-series models. Parameters to capture stochastic seasonal effects and stochastic time trends were included in the models. The main outcome measures were changes in the number, proportion and timeliness of A&E and GP examinations reported.	Radiographer reporting X-ray examinations requested by A&E was associated with a 12% increase in the number of A&E examinations reported and a 37% decrease in the time taken to report on these examinations. Radiographer reporting of A&E X-ray examinations was also associated with a 14% decrease in the time taken for GP examinations to be reported. That is, radiographer reporting A&E X-ray examinations allowed an increase in the time available to radiologists to report on examinations requested by GPs. An increase in the proportion of GP examinations reported by radiologists was associated with longer reporting times for A&E examinations.  In conclusion, selectively trained radiographers reporting on A&E X-ray examinations significantly improved the availability of reports for A&E and GP examinations.
Canadian Association of Medical Radiation Technologists. CAMRT Scope of Practice. Undated. <a href="http://www.camrt.ca/">www.camrt.ca/</a>	This document outlines the professional role, education, decision making, expectations, accountability, responsibilities, advanced practice and emerging roles of MRTs.	The scope of practice for the profession of Medical Radiation Technology involves the safe and effective application of all competencies through best practices encompassed in the use of ionizing radiation and other energy forms. It includes producing diagnostic images and performing diagnostic and therapeutic interventions, as well as the evaluation and assessment of such images and therapeutic applications.  Areas identified for potential future expansion of MRTs includes: <ul style="list-style-type: none"> <li>▪ Medical research / clinical trials</li> <li>▪ Promotion of healthy lifestyles</li> <li>▪ PACS (Picture Archival and Communication System) administration</li> <li>▪ Digitalization of x-ray images</li> <li>▪ Teleradiology</li> <li>▪ 3D imaging</li> <li>▪ CT / PET imaging</li> <li>▪ Bone densitometry</li> <li>▪ Synchrotron radiation</li> <li>▪ Fusion imaging</li> <li>▪ Molecular imaging.</li> </ul>
Canadian Association of Radiologists. Imaging the Future. Final Report. 2004.	Final report on a project initiated by the Canadian Association of Radiologists (CAR) to provide methodological rigour to the identification and consideration of pending changes in diagnostic imaging in the context of the Canadian health care system.	The following were identified as the most significant issues which CAR could have direct influence on: <ol style="list-style-type: none"> <li>1. How costs are contained in health care services;</li> <li>2. How to manage the growing radiology workload given a continuing manpower shortage, and;</li> <li>3. The place of interventional radiology in medicine.</li> </ol>

		A survey of the membership as well as focus groups informed potential issues for action by the CAR and provided input on possible directions.
Canadian Association of Radiologists. Vision 2000: Medical Imaging Services in Canada. In partnership with Organized Radiology – Canadian Heads of Academic Radiology and the Medical Imaging Industry. 2000.	Joint position paper between the Canadian Association of Radiologists, the Canadian Heads of Academic Radiology and the Medical Imaging Industry. The paper calls for a new vision for medical imaging services in Canada to respond to the health human resource challenges in radiology and evolving health care technology.	A major factor contributing to access problems in the health system is associated with the lack of access to high-tech equipment and human resources. Shortages of high-tech equipment and skilled personnel are impeding early diagnosis and inhibiting high quality treatment for patients.  The paper recommends that a “National Medical Imaging Advisory Committee” be created by the Minister of Health to provide advice on trends and recommendations needed to address current and anticipated medical imaging challenges in Canada.
College of Radiographers [United Kingdom]. Radiography: The Scope of Practice 2003. First edition. March 2003.	This paper seeks to clarify: - the current scope of practice for radiographers to support the profession in clearly defining (and justifying) their role and purpose - the education, training and other support that is necessary to effectively facilitate developing roles.	
College of Radiographers [United Kingdom]. Role Development Revisited: The Research Evidence 2003. <i>Radiography</i> . 2003.	Longitudinal study undertaken to identify current practice that included a review of the literature, qualitative interviews with members of the various special interest groups in radiography, chairs of regional committees, representatives from higher education institutions, individual radiographers and officers of the Society and College of Radiographers.	In the last decade, the scope of practice for radiographers has been enhanced. The profession has seized opportunities for role development in response to changing health care needs and now undertake new responsibilities in every area of diagnostic imaging and radiotherapy.  The Society and College of Radiographers have encouraged and supported radiographers to extend their scope of practice and continue to explore opportunities for further role development.  The results of the study clearly demonstrated that radiographers’ roles have changed significantly, with the emergence of many new roles. Radiographers have embraced opportunities for role development primarily in response to the demands of the service. Education provision and the research base have also continued to develop to support the changing scope of practice.
Elliot, L. Radiographer reporting in the nuclear medicine department: a learning curve? <i>Radiography</i> . Vol 9:247-251. 2003.	Editorial review article in an academic medical journal.	The wider development of radiographers in a developed role will bring enormous benefits to the patient. Reporting by radiographers is a requirement (not an option) for the future.  Enhancement of roles will also enhance job satisfaction among radiographers.

<p>Ellis, T. et al. Multidisciplinary radiographer-led Clinics: An Example of Implementation. <i>Journal of Radiotherapy in Practice</i>. Vol 5. 87-95. 2006.</p>	<p>Describes how one department implemented a change in direction from conventional clinician-led practice re: treatment of radiotherapy patients to radiographer-led review clinics.</p>	<p>In recent years there has been a push to move away from traditional clinician-led treatment review of radiotherapy patients. The UK has undertaken some research in this area. Issues to be considered in enhancing radiographer-led participation include: training, time, space and frequency of medic input.</p> <p>There are a complex variety of formats and personnel involved in the review of patients undergoing radiotherapy across the UK. When deciding which profession is best suited for this task a number of issues beyond role expansion or time need to be considered.</p> <p>Although based on small numbers radiographer-led activity may serve as an early model for radiotherapy departments elsewhere. Those involved with non-medic review of patients undergoing radiotherapy believe moving away from traditional reviews frees up clinician time and provides patients with more detailed review during their treatment.</p> <p><u>Limitations:</u> As patients had not gone through the conventional system of patient reviews, comparisons of the two services were not able to be made - a possible flaw in the evaluation was not interviewing patients passing through the conventional system.</p>
<p>Hardy, M. and Snaith, B. Role Extension and Role Advancement – Is There a Difference? <i>Radiography</i>. Vol 12. 327-331. 2006.</p>	<p>The terms ‘extended’ or ‘advanced’ practice are commonly used to describe clinical practitioner roles; however, these terms have not been clearly defined within the context of modern radiography practice.</p>	<p>The radiography profession in the UK has been proactive in challenging the scope of clinical practice. However, to achieve recognition as advanced practitioners, radiographers need to evolve from discrete task based practices and develop their roles within the wider context of health care provision. This development requires investment at the individual, organizational and professional level if it is to become embedded within the modern radiography career framework.</p> <p>Educators need to work with clinical partners to ensure that such professional evolution is appropriately directed and supported by opportunities for practitioners to independently explore and research practice innovations.</p>
<p>Hargreaves, J. and Mackay, S. The Accuracy of the Red Dot System: Can it Improve with Training? <i>Radiography</i>. Vol 9. 283-289. 2003.</p>	<p>Study investigating whether the introduction of a training programme for radiographers (covering the basic principles of pattern recognition and fracture detection) could increase their ability to exclude fractures within a “red dot system.” The red dot system is used in trauma radiology to highlight acute abnormalities for the casualty officer. For a period of 8 weeks seven radiographers were monitored with respect to their sensitivity, specificity and accuracy of use of the red dot. These radiographers were then given a 10-week training programme in the basic principles</p>	<p>The accuracy of the radiographers as a group increased from 89.9% before the training to 93% after. Sensitivity for fracture detection increased from 76.2% to 81.3%. Specificity for fracture exclusion decreased slightly from 96.4% to 96.1%. These differences were not statistically significant. The false positive rate remained at 3% whereas the false negative rate fell from 7% to 4%.</p> <p>Although the results were not statistically significant, there is evidence to suggest that in this context training had an overall positive effect on the use of the red dot system by this team of radiographers. Future training programmes should focus on the areas of joint effusion, hand fracture, lower limb fracture and epiphyses which was where the errors arose within this study.</p>

	<p>of trauma radiology. Their sensitivity, specificity and accuracy were monitored for a period of 8 weeks following the training. Statistical analysis was undertaken using a student's test for paired samples working at the 0.05% level of significance.</p>	
<p>Hawnaur, Jane. Diagnostic Radiology. <i>British Medical Journal</i>. Vol 319. 368-171. 1999.</p>	<p>This review discusses changes in the technology and other aspects of radiology and how changes have impacted on clinical practice.</p>	<p>All types of diagnostic images can now be acquired as digital signals. Digital imaging and developments in computer technology and telecommunications mean that the "filmless" radiology department is technically feasible.</p> <p>Faster image acquisition in computed tomography has extended its diagnostic applications, but has implications for the population radiation dose from medical imaging. Magnetic resonance imaging continues to develop rapidly, propelled by the benefits of shorter scan times and the potential to provide functional information. New or updated radiology equipment and techniques are expensive and may not be cost effective in every radiology department.</p>
<p>Hogg, Peter. Advanced Clinical Practice for Radiographers in Great Britain: Professional Roles, Accountability and the Educational Provision. <i>The Canadian Journal of Medical Radiation Technology</i>. Vol 35:4. Winter 2004.</p>	<p>This paper explores the current arrangements for radiographers' roles and responsibilities including their accountability and the educational level at which advanced competencies are learned and assessed.</p>	<p>Advanced (practice) clinical roles for UK radiographers have increased rapidly in the past decade. Jobs traditionally done by radiologists are now being undertaken by radiographers. Advanced roles for radiographers in the UK include:</p> <ul style="list-style-type: none"> <li>▪ Justifying and <i>prescribing</i> drugs</li> <li>▪ Reading /reporting medical images</li> <li>▪ Conducting complex procedures (e.g., biopsies and barium procedures)</li> <li>▪ Performing therapeutic procedures</li> <li>▪ Informing patients of results</li> <li>▪ Leading clinical research projects</li> <li>▪ Requesting further x-ray imaging as required</li> </ul> <p>Expansion of the radiographers' responsibilities is not happening in an unregulated fashion but is unfolding within a supportive framework of policy and law that is based upon an ever-increasing evidence base. An education and training provision exists at "various levels" to address specific needs and, like clinical practice, this too is evolving as demand dictates.</p>
<p>Murphy, M. et al. A Comparison of Radiographer and Radiologist Reports on Radiographer Conducted Barium Enemas. <i>Radiography</i>. Vol: 8. 215-221. 2002.</p>	<p>Compares radiographer and radiologist reports on radiographer conducted barium enemas. Two specially trained, experienced radiographers performed barium enemas and prepared provisional reports without consulting radiologists. Later, formal radiologist reports were issued. The reports of each were compared and correlated with clinical findings derived from case note review.</p>	<p>Radiographers with specialized training can report barium enemas to a high standard. Seven hundred and eighty-eight patients had barium enemas. Males numbered 295 (37.5%) and females 493 (62.5%). Patients' ages ranged from 17 to 95 years (mean 62). The radiologist reported 244 as normal, 432 as diverticular change, 70 with polyps (31 of which had co-existent diverticular disease), 31 with carcinomas and 12 with colitis (three of which had co-existent diverticular disease). Taking the radiologist reports as gold-standard radiographer reports were concordant in 753 (95.5%). There were 35 (4.5%) discordant radiographer reports, and of these, 19</p>

		<p>were false-positive diagnoses of polyps and six false-positive diagnoses of diverticular change. There were seven false-negative diagnoses of polyps. There was one false-negative diagnosis of colitis and two false-negative reports of diverticular change.</p> <p>On follow up there were no false-negative diagnoses of carcinoma by either radiographer or radiologist. There was one concordant false-positive diagnosis of carcinoma.</p>
<p>Nightingale, Julie and Hogg, P. The Gastrointestinal Advanced Practitioner: an Emerging Role for the Modern Radiology Service. <i>Radiography</i>. Vol 9. 151-160. 2003.</p>	<p>Radiographer role development in the field of gastrointestinal (GI) imaging is a growing sub-specialty with radiographers in many National Health Service (NHS) Trust hospitals performing a range of examinations that were formerly performed by the radiologist. The emergence of this advanced role has been rapid and sustained, with practitioners continually pushing the traditional practice boundaries within this specialty.</p>	<p>The performing of barium enema examinations by radiographers is now established and widely accepted across the UK, and many radiographers have successfully advanced their practice to incorporate a range of other GI investigations. Although GI radiographers are a relatively new addition to the radiology team, they have proved their effectiveness in providing GI services.</p>
<p>Nightingale, Julie and Hogg, P. The Role of a GI Radiographer: A United Kingdom Perspective. <i>Radiologic Technology</i>. March-April 2007.</p>	<p>In the United States the concept of the radiologist assistant (RA) was proposed to address the issues of radiologist shortages and rising workloads. The first cohort of RAs (radiologist extenders who work under the supervision of a radiologist)—have graduated and is set to change the way radiology is practiced in the United States.</p>	<p>RA scope of practice includes a range of patient management and fluoroscopy procedures. The RA is an experienced, registered radiologic technologist who has successfully completed an advanced academic program at either the baccalaureate or post baccalaureate level encompassing both nationally approved curricula and a clinical preceptorship. This is not dissimilar to the education of some GI radiographers in the United Kingdom; however, there is no legal or professional requirement for U.K. radiographers to have attended an accredited postgraduate program. Most radiographers attend short, ungraded courses for initial DCBE training, coupled with in-house clinical training. However, to attain the higher levels of the career structure (what are known in the United Kingdom as advanced and consultant practitioner positions), there is an increasing expectation that GI radiographers will have completed relevant studies at the master's degree level.</p> <p>The lessons learned from the United Kingdom's experience with GI radiographers have the potential to be transferred to the newly introduced RA role in the United States. As this role takes shape in the near future, radiologists and radiologic technologists should be reassured that the transition of roles from one professional domain to another can be relatively smooth and painless. The RA role has the potential to be of maximum benefit to both professions and, more importantly, to the patients that they serve.</p> <p>Radiographer-performed DCBE examinations now are well established in the United Kingdom, and an expanding evidence base has shown that GI radiographers can perform and read such</p>

		<p>examinations successfully to an adequate standard. Radiographers can adapt their skills to perform both existing and new techniques, such as CT colonography, that may replace the DCBE in the future. In recognition of their expert clinical abilities, they can be rewarded with elevated status and pay within a new career structure.</p>
<p>Paterson, A. et al. Reporting by Radiographers: A Policy and Practice Guide. <i>Radiography</i>. Vol 10. 205-212. 2004.</p>	<p>Reporting by radiographers and other non-medical staff has developed considerably in the past decade, especially since the College of Radiographers published its vision paper on reporting by radiographers, in 1997.</p>	<p>This Guide provides assistance to radiographers and others undertaking radiographic reporting. It includes guidance on planning and implementing a reporting service using reporting radiographers; the education, continuing education and support required by reporting radiographers; quality and standards related to reporting; and the nature of a report.</p>
<p>Price, R.C. and Le Masurier, S.B. Longitudinal changes in extended roles in radiography: A new perspective. <i>Radiography</i>. Vol 13. 18-29. 2007.</p>	<p>This study updates data on changes related to scope of radiographic practice since the principal author's previous survey in 2000. Structured questionnaires were sent to radiology managers at acute National Health Service (NHS) trusts across the United Kingdom. Information sought included region, teaching/non-teaching status, the nature of extended role tasks undertaken and the year in which these tasks were adopted, numbers of radiographers and radiologists in post. Information was also sought on the implementation of the '4-tier structure'. 177 of 258 questionnaires were returned (68.6% response rate).</p>	<p>In 166 trusts, radiographers administered intravenous injections; they performed barium enemas in 147 trusts and barium meals in 19 trusts, while a red dot system was in operation in 143 trusts. Each category showed an increase from that reported in 2000.</p> <p>Reporting by radiographers had also increased since 2000. Responses indicated that at 146 trusts, radiographers were reporting in ultrasound; reporting of the appendicular skeleton was undertaken at 81 trusts and axial skeletal reporting at 70 trusts. Barium enemas were reported by radiographers in 78 trusts. Reporting was also undertaken by radiographers on barium meals, mammography, nuclear medicine, paediatric and chest radiography; and all showed an increase in frequency since 2000.</p> <p>Regional differences were apparent in reporting, with a greater prevalence in the English regions, with the exception of London.</p> <p>In respect of the 4-tier structure, 59% of the sample employed assistant practitioners, 47% advanced practitioners and 3% employed consultants. The numbers reported in each category (excluding practitioners) were 158 assistants, 623 advanced practitioners and six consultants. There were a number of trusts that had plans to introduce assistants, advanced practitioners and/or consultants over the following two-year period.</p>
<p>Robinson, P.J.A. et al. Interpretation of Selected Accident and Emergency Radiographic Examinations by Radiographers: A Review of 11000 Cases. <i>The British Journal of Radiography</i>. Vol 72. 546-551. 1999.</p>	<p>Two specially trained radiographers took part in the radiologists' rotation for 'cold' reporting skeletal radiographs of patients who attended the Accident and Emergency (A&amp;E) Department at times when there was no 'hot' reporting service operating, and who were not admitted for treatment or referred to fracture clinics for follow-up. A&amp;E staff had originally seen these radiographs.</p>	<p>At the end of an 18 month period during which the two radiographers reported on 11,322 skeletal examinations, a retrospective search was made to detect interpretive errors. The radiological history of all patients was reviewed over a follow-up period of at least three months subsequent to the attendance reported by radiographers. 48% of patients did not re-attend, 42% re-attended for unrelated examinations, and 10% re-attended for repeat examinations of the same anatomical area, or for different procedures related to the original injury.</p> <p>The article concludes that appropriately trained and supervised radiographers can successfully undertake</p>

		diagnostic reporting of selected skeletal examinations on A&E patients.
White, P. and MacKay, J.C. Guidelines and Legal Requirements Which Inform Role Expansion in Radiography. <i>Radiography</i> . Vol 8. 71-78. 2002.	<p>Role expansion in radiography is linked to ethico-legal responsibilities and accountability. This paper clarifies the legal requirements, outlines professional guidelines, and suggests that role developments require new rules and standards.</p> <p>A thorough review of the literature was used to collect information on role expansion and related topics, such as Continuous Professional Development (CPD) and skills mix. Emphasis was placed on case law and professional guidelines.</p>	<p>Radiographers who develop their roles must continue to provide a high quality service and demonstrate high level competencies, skills and knowledge. When deciding who should provide the service, the ultimate decision should be based on client benefit. Radiographers who expand their role will be gauged against specialists in that field. If a radiographer claims to be a specialist, the standard of care is that of the reasonable specialist and not that of the general radiographer. In legal terms, a patient is entitled to a greater standard of care from a specialist than from an ordinary practitioner and radiographers must meet that standard.</p> <p>Role expansion in radiography has associated legal responsibilities and radiographers are accountable for acts or omissions arising out of practice. Guidelines should be established which ensure that radiographers have skills and knowledge on a par with specialists in their area of practice so as to maintain the maximum benefit to the client.</p>

## Health System Changes/Trends

Authors, Title and Publication	Context/Type of Document	Main Findings/Recommendations
<p>2006 Annual Report of the Office of the Auditor General of Ontario: 3.06 Hospitals – Management and Use of Diagnostic Imaging Equipment.</p>	<p>The objective of the Auditor’s review was to assess whether selected hospitals had adequate policies and procedures in place to ensure that the management and use of medical imaging equipment (particularly MRI and CT equipment) meets patient needs efficiently and is in compliance with applicable legislation, and that test results are accurately reported on a timely basis.</p> <p>The audit work was conducted at three hospitals of different sizes that provide services to a variety of communities (Grand River Hospital serving the region of Waterloo and area; University Health Network in Toronto comprised of the Toronto General Hospital, the Toronto Western Hospital and the Princess Margaret Hospital; and Peterborough Regional Health Centre serving Peterborough and area). In conducting the audit, relevant files and administrative policies and procedures were reviewed, appropriate hospital and ministry staff were interviewed, and relevant research including that on the delivery of diagnostic imaging services in other jurisdictions was reviewed. The delivery of diagnostic services—in particular MRI and CT examinations—in Ontario was discussed with representatives of the Canadian Association of Radiologists, the Ontario Association of Medical Radiation Technologists, the Healing Arts Radiation Protection Commission, and the Ministry’s Expert Panel on MRI and CT.</p>	<p>Due to scope limitations, the audit was unable to fully assess whether the Ministry had adequate processes in place to ensure that private-sector and hospital laboratories were complying with applicable legislation and established policies and procedures. It was determined, however, that the Ministry had adequate procedures to ensure that specimen-collection centres were complying.</p> <p>Recommendations:</p> <ul style="list-style-type: none"> <li>▪ Hospitals in conjunction with the Ministry should evaluate the benefits of using diagnostic imaging referral guidelines, such as those issued by the Canadian Association of Radiologists, to assist with determining the appropriateness of tests and have a process in place to identify possibly inappropriate diagnostic imaging tests ordered by referring physicians, particularly with respect to CT and MRI referrals. This will better ensure patients receive the most appropriate diagnostic tests, while reducing unnecessary tests, wait times and unnecessary exposure to radiation.</li> <li>▪ Hospitals should establish policies to ensure that all patients, including Workplace Safety and Insurance Board patients are prioritized for MRI and CT examinations in a similar manner based on medical need.</li> <li>▪ Hospitals should seek further guidance from the Ministry to clarify the starting point for the calculation of each patient’s wait time, to ensure that wait-time data are being consistently reported across all hospitals and measure and report wait times using the Ministry’s new Wait Time Information System to better manage their MRI and CT waiting lists and provide the public with more reliable and useful wait time information.</li> <li>▪ Hospitals should monitor the reasons for cancellations and take proactive action where possible to minimize the impact of last-minute cancellations and no-shows to ensure that hospitals are utilizing their MRI and CT equipment efficiently.</li> <li>▪ Hospitals and the Ministry should develop strategies to increase the utilization of MRI and CT equipment, including increasing the time available for performing clinical procedures to provide patients with timely access to required examinations.</li> <li>▪ To help ensure the safety of patients and hospital staff with regard to the operation of MRIs, hospitals should address the recommendations endorsed by the Ontario Health Technology Advisory Committee, which were designed to promote consistent and safe MRI practices in Ontario.</li> </ul>

		<p>Hospitals should ensure that both physicians and patients are aware of the radiation exposure from CTs in order to make better informed decisions on the use of CTs versus other diagnostic imaging options; develop and implement standardized patient CT-radiation-exposure protocols, based on international and national best practices, that would ensure that the patient's radiation exposure is as low as reasonably achievable and is consistent among hospitals; obtain information from other hospitals regarding CTs and other diagnostic imaging procedures for those patients who have had or will have a significant number of such examinations; and ensure that all hospital personnel exposed to occupational radiation wear the recommended dosimeters to enable accurate tracking of radiation to ensure radiation exposure does not exceed the limits established in the <i>Occupational Health and Safety Act</i>. To help minimize the impact of radiation exposure for patients and hospital personnel, hospitals, in conjunction with the Ministry:</p> <ul style="list-style-type: none"> <li>▪ Ministry of Health and Long-Term Care should review and take appropriate action on the recommendations of the Healing Arts Radiation Protection Commission and the Ontario Health Technology Advisory Committee, and ensure that CT operations are subject to an appropriate level of review.</li> <li>▪ To help ensure that referring physicians have accurate information on a timely basis for making patient-related decisions, hospitals should adopt benchmarks for the timely reporting of both urgent and normal MRI and CT referrals and monitor adherence to those benchmarks; implement an independent quality assurance program that includes a periodic, preferably external, review of a sample of each radiologist's analysis of diagnostic images.</li> </ul>
<p>Brealy, S. The Costs and Effects of Introducing Selectively Trained Radiographers to an A&amp;E Reporting Service: A Retrospective Controlled Before and After Study. <i>The British Journal of Radiology</i>. Vol 78. 499-505. 2005.</p>	<p>The costs and effects of introducing selectively trained radiographers reporting accident and emergency (A&amp;E) radiographs of the appendicular skeleton in a district general hospital were assessed using a retrospective controlled before and after design. Reference standard reports were compared with a random stratified sample of 200 A&amp;E and 200 general practitioner (GP) reports before and after the intervention. GP reports were used as a non-intervention, non-equivalent control group. An A&amp;E specialist registrar judged whether incorrect A&amp;E reports might have a clinically important effect on patient management. The effect of incorrect A&amp;E reports on</p>	<p>The study provides further evidence that selectively trained radiographers can accurately report A&amp;E plain radiographs and at no additional cost.</p> <p>The introduction of the radiographers resulted in a 1% fall in A&amp;E radiograph reporting accuracy and 11% reduction of cases in which incorrect A&amp;E reports might have a clinically important effect on patient management. Only two A&amp;E reports (one before and one after the intervention) affected patient outcome in that a fracture missed at the first visit resulted in patient re-attendance to the X-ray Department.</p> <p>There were measurable annual savings to the X-ray Department.</p>

	<p>outcome was assessed by patient re-attendance to the hospital because of missed abnormalities. The annual, average and incremental costs of radiographers and radiologists reporting A&amp;E radiographs were calculated and a sensitivity analysis was undertaken.</p>	
<p>Canadian Association of Medical Radiation Technologists. Supply and Demand Study of Utilization of Medical Radiation Technologists in Canada. September 2006.</p>	<p>This project was completed as part of the framework developed for the Government of Canada's Foreign Credential Recognition Program, "A Situational Analysis and Recommendations for Internationally Educated Medical Radiation Technologists."</p> <p>This study collected general supply information for the four MRT disciplines from existing national and provincial databases. Information on the demand for MRTs across Canada was not available, so CAMRT conducted the first demand survey for MRTs in diagnostic imaging departments and cancer centres across Canada.</p> <p>This report provides details on the methodology of the study, data limitations, and the key findings.</p>	<p>Several factors point towards a shortage in the supply of MRTs in Canada. An aging workforce, ever-changing technology, and predominantly female workers all predict a need for an increase in the supply of MRTs.</p> <p>There are high MRT vacancy rates in a number of areas particularly for radiological technologists (7%) and magnetic resonance technologists (8%), across Canada. Workforce shortages contribute to increased patient wait times, cancelled procedures, decreased patient satisfaction, plans to stop offering a specific service, etc.</p> <p>Human resource shortages of MRTs in the Canadian workplace are expected to worsen as both the aging MRT workforce leads to increased retirements and the aging Canadian population demands more health services.</p> <p>The collection of regular supply and demand information for MRTs in the Canadian health care system is needed to inform human resource planning and forecasting.</p>
<p>Canadian Institute for Health Information. Medical Imaging in Canada, 2007. Ottawa. 2008.</p>	<p>This report aims to address the gap in information regarding the actual use of medical imaging technologies in Canada. The report provides an overview of what is known about medical imaging across Canada including the numbers and kinds of machines, how they are used, and information about the skilled health professionals who operate the equipment and interpret results.</p>	<p>Highlights of the Report:</p> <ul style="list-style-type: none"> <li>▪ Data from the Canadian MIS Database indicate that basic X-ray and ultrasound still account for nearly 80% of all medical imaging examinations in Canadian hospitals.</li> <li>▪ In 1990, 17 years after their introduction, there were 198 CT scanners installed and operational in Canada. By 2007, the number of CT scanners had reached 419, more than double the number in 1990. MRI scanners were introduced at a later date and their number was still quite low in 1990 (19). By 2007, 222 MRI scanners were installed and operational.</li> <li>▪ The first hybrid PET/CT scanner was installed in Canada in 2002. From that time to January 1, 2007, 17 PET/CT scanners were added. As of January 1, 2007, there were more PET/CT scanners installed and operational (18) than there were PET scanners (13).</li> <li>▪ For hospital-based equipment captured in the survey, funding for operating costs comes primarily from provincial and territorial governments. Additional secondary funding sources also exist. For example, some hospitals provide CT and MRI services funded by other payers in off hours. In contrast, the private</li> </ul>

		<p>sector (private health insurance and households) provides most of the funds to finance the operation of machines housed in free-standing imaging facilities.</p> <ul style="list-style-type: none"> <li>▪ At 6.1 MRI scanners per million population on January 1, 2006, Canada was below the median of Organisation for Economic Co-operation and Development (OECD) countries in 2005 (6.9). For CT, with 12.1 scanners per million population on January 1, 2006, Canada is also below the 2005 OECD median (14.7). Intensity of operation of scanners may vary between countries and, consequently, low rates of scanners do not necessarily mean low rates of exams.</li> <li>▪ At the Canada-wide level, between 2003–2004 and 2006–2007, the increase in the number of exams was greater than in the number of scanners, both for MRI and CT. In the case of MRI, a 27% growth in the number of scanners led to a 47% growth in the number of exams. In the case of CT, a 12% growth in the number of scanners led to a 32% growth in the number of exams.</li> <li>▪ For jurisdictions with MRI scanners in free-standing facilities (Quebec, Ontario, Manitoba, Alberta and B.C.), the average number of MRI exams per scanner was 5,970 in the hospital setting, compared with 2,530 in the free-standing setting in 2006–2007.</li> <li>▪ For jurisdictions with CT scanners in free-standing facilities (Quebec, Ontario, Alberta and B.C.), the average number of CT exams per scanner was 9,506 in the hospital setting, compared with 2,160 in the free-standing setting in 2006–2007.</li> <li>▪ Canada’s 16,464 medical radiation technologists (MRTs) made up the bulk of the medical imaging workforce in 2006. They include radiological, nuclear medicine, radiation therapy and magnetic resonance technologists. Seventy-four percent of MRTs are radiological technologists.</li> <li>▪ The level of education required to work in medical imaging varies from profession to profession. For example, it may take from two to four years to become a magnetic resonance imaging technologist following high school graduation. For paediatric radiology physicians and neuroradiology physicians, training may take 14 years.</li> </ul>
<p>Fred, Herbert. Drawbacks and Limitations of Computerized Tomography: Views from a Medical Educator. <i>Texas Heart Institute Journal</i>. Vol 31: 4. 2004.</p>	<p>Academic editorial that argues that when computed tomography (CT) became available in the 1970s, it enabled practitioners to establish diagnoses with unprecedented speed and accuracy, but it also affected the way those practitioners practice and teach medicine, shifting the focus from the bedside to the</p>	<p>Drawbacks of CT:</p> <ul style="list-style-type: none"> <li>▪ Cost</li> <li>▪ High Radiation Dosage</li> <li>▪ “Promotes Laziness”: physicians can “fish” for diagnosis - the physician takes a brief medical history, may or may not examine the patient, and, guided by the chief complaint, proceeds directly to CT scanning</li> </ul>

	<p>laboratory and giving rise to a “malady that has slowly pervaded our profession... ‘technologic tenesmus’ — the uncontrollable urge to rely on sophisticated medical gadgetry for diagnoses.”</p>	<p>Limitations of CT scanning:</p> <ul style="list-style-type: none"> <li>▪ Not always available</li> <li>▪ Cannot replace a pertinent medical history or physical examination</li> <li>▪ Cannot substitute for examining the spinal fluid</li> <li>▪ Cannot provide histologic evidence</li> </ul> <p>Indiscriminate use of computed tomography is rampant and may be doing more harm than good. Health professionals should use CT only when no other test or procedure can supply the information needed. Radiologists (particularly those who deal with children) should strive to reduce the radiation dose in each patient to the lowest level capable of yielding acceptable image quality. They should also question the use of CT when the indications do not seem appropriate. Finally, medical schools should bring these issues to the attention of students and house officers.</p>
<p>Glaves, J. The Use of Radiological Guidelines to achieve a sustained reduction in the number of radiographic examinations of the cervical spine, lumbar spine and knees performed for GPs. <i>Clinical Radiology</i>. Vol 60. 914-920. 2005.</p>	<p>This paper aims to determine if the use of request guidelines can achieve a sustained reduction in the number of radiographic examinations of the cervical spine, lumbar spine and knee joints performed for general practitioners (GPs).</p> <p>GPs referring to three community hospitals and a district general hospital were circulated with referral guidelines for radiography of the cervical spine, lumbar spine and knee, and all requests for these three examinations were checked. Requests that did not fit the guidelines were returned to the GP with an explanatory letter and a further copy of the guidelines. Where applicable, a large joint replacement algorithm was also enclosed. If the GP maintained the opinion that the examination was indicated, she or he had the option of supplying further justifying information in writing or speaking to a consultant radiologist.</p>	<p>Overall the number of radiographic examinations fell by 68% in the first year, achieving a 79% reduction in the second year. For knees, lumbar spine and cervical spine radiographs the total reductions were 77%, 78% and 86%, respectively.</p> <p>The use of referral guidelines, reinforced by request checking and clinical management algorithms, can produce a dramatic and sustained reduction in the number of radiographs of the cervical spine, lumbar spine and knees performed for GPs.</p>
<p>Healing Arts Radiation Protection (HARP) Commission Report. June 2007.</p>	<p>In February 2005, the HARP Commission was asked by the Ontario Ministry of Health and Long-Term Care to review the guidelines and regulations — Section 16(1) of the Healing Arts Radiation Protection (HARP) Act — concerning the registration and operation of computed tomography (CT) scanners in dental facilities in Ontario.</p>	<p>Key Recommendations:</p> <p><b>THE HARP ACT SHOULD:</b></p> <ul style="list-style-type: none"> <li>▪ Be revised to include a definition of a “computerized axial tomography (CT) scanner or machine.”</li> <li>▪ Recognize that the radiation doses associated with CT examinations are higher than those associated with conventional x-ray examinations.</li> <li>▪ Cover all forms of ionizing radiation. This encompasses all CT technologies, as well as all</li> </ul>

	<p>The HARP Commission undertook a study of all facets of CT, reviewed various studies, including the University Health Human Factors Report, 2007, the Diagnostic Imaging Safety Committee Report, 2007, and the Auditor General’s Report, 2006. The Commission also consulted with specialists in the field of radiation, focusing on topics such as:</p> <ul style="list-style-type: none"> <li>▪ CT scanners in hospitals and dental facilities;</li> <li>▪ potential effects of CT radiation;</li> <li>▪ CT radiation dosage;</li> <li>▪ protective accessories;</li> <li>▪ CT operators’ qualifications and certification;</li> <li>▪ checks and balances for persons prescribing CT examinations and operating CT scanners;</li> <li>▪ duties of Radiation Protection Officers and of Medical Radiologists;</li> <li>▪ added responsibilities of the X-ray Inspection Service; and</li> <li>▪ education.</li> </ul>	<p>applications to human beings, including diagnostic, therapeutic, analytical, and research purposes.</p> <ul style="list-style-type: none"> <li>▪ Require that prescribing or requesting a CT examination be permitted only by those individuals who have the appropriate clinical knowledge of and safety training in radiation.</li> <li>▪ Provide guidelines on the installation, process, use, and testing of CT equipment.</li> <li>▪ Be revised to reflect changes to the role and duties of the X-ray Safety Inspector, so that the Inspector is able to perform and/or audit the inspection and maintenance of CT scanners, including dental cone beam CT scanners and all ionizing radiation devices.</li> </ul> <p><b>OPERATION OF RADIATION EMITTING DEVICES</b></p> <ul style="list-style-type: none"> <li>▪ All persons who operate CT radiation equipment or devices shall have technical expertise in and knowledge of radiation safety, and shall have taken radiation safety courses. This qualification shall be documented by a certificate of credentials.</li> <li>▪ It is the responsibility of the Radiation Protection Officer of a facility to ensure that only those with certification in CT radiation safety shall operate radiation equipment or devices, including CT and fluoroscopy machines.</li> <li>▪ All staff and students involved in the use of fluoroscopy shall receive formal training which would allow them to have minimal qualifications in fluoroscopy.</li> </ul> <p><b>RADIATION DOSAGE</b></p> <ul style="list-style-type: none"> <li>▪ Regulations on radiation dosage must encompass all radiation technologies and devices in use in Ontario.</li> <li>▪ Radiation dose maximums must be set for all CT scans, taking into consideration the procedure and the particular CT scanner used (i.e., number of slices and patient’s body mass).</li> <li>▪ Manufacturers of CT scanners must suggest protocols specifically for children that can be adjusted for age, weight, and the body parts being scanned.</li> <li>▪ Dosage protocols for CT examinations must be regulated at all healthcare facilities.</li> <li>▪ Diagnostic Reference Levels must be established for all diagnostic examinations using CT.</li> <li>▪ Diagnostic Reference Levels should be used as guidelines in the formulation of dosage regulations.</li> <li>▪ The ALARA (As Low As Reasonably Achievable) principle must be adhered to whenever a CT examination is performed.</li> <li>▪ All CT facilities must be assessed with regard to operations and dosage on a regular basis.</li> </ul>
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<p>Heitman, S. et al. Cost-effectiveness of computerized tomographic colonography versus colonoscopy for colorectal cancer screening. <i>Canadian Medical Association Journal</i>. 173: 8. 2005.</p>	<p>An economic evaluation, using decision analysis, was performed to compare CT colonography with colonoscopy for colorectal cancer screening in patients over 50 years of age.</p> <p>Three-year outcomes included number of colonoscopies, perforations and adenomas removed; deaths from perforation and from colorectal cancer from missed adenomas; and direct health care costs. The expected prevalence of adenomas, test performance characteristics of CT colonography and colonoscopy, and probability of colonoscopy complications and cancer from missed adenomas were derived from the literature. Costs were determined in detail locally.</p>	<p>Conclusion: At present, CT colonography cannot be recommended as a primary means of population-based colorectal cancer screening in Canada.</p>
<p>Institute for Clinical and Evaluative Sciences. Diagnostic Services in Ontario: Descriptive Analysis and Jurisdictional Review. April 2007 (revised).</p>	<p>The Diagnostic Services Committee (DSC), with representation from the Ontario Medical Association, the Ontario Hospital Association, and the Ontario Ministry of Health and Long-Term Care (MOHLTC), was established through the Physician Services Framework Agreement to provide advice to the Minister of Health and Long-Term Care on the planning and coordination of the diagnostic services system in Ontario. A key priority was to establish strategic goals and directions for Ontario’s diagnostic services system. The DSC asked the Institute for Clinical Evaluative Sciences (ICES) to describe the extent to which diagnostic imaging</p>	<p>Recommendations and policy options for Ontario:</p> <ul style="list-style-type: none"> <li>▪ Consultation with other national and international organizations is necessary to develop a standard and comprehensive method for recording and reporting diagnostic service utilization and cost. Attention to the cost of diagnostic imaging tests themselves as well as to downstream savings and costs is required.</li> <li>▪ A universal, province-wide, web-based system for ordering diagnostic imaging tests should be adopted to allow clinicians to access the results of previous imaging tests and thus decrease the frequency of unnecessary repeat testing. Until such a system is adopted, targeted chart reviews could prove useful for identifying areas where appropriateness of testing may be a concern.</li> <li>▪ A population-based study that seeks to understand the relationship between the intensity of diagnostic imaging use and health outcomes in Ontario is necessary in order to</li> </ul>

	<p>services are currently provided to patients, and to provide information about how Ontario manages these services in the context of other national and international jurisdictions. A descriptive analysis of the utilization of diagnostic services in Ontario and a review of the management of these services in a number of selected jurisdictions was undertaken. This report focuses on diagnostic imaging technologies given that they comprise the majority of technologically advanced, high cost and rapidly growing diagnostic services in Ontario. Laboratory and pathology services as well as genetic testing were excluded.</p>	<p>fully understand reports from the US Medicare population which suggest that higher spending for diagnostic imaging does not lead to improved health outcomes.</p> <ul style="list-style-type: none"> <li>■ Investment is recommended in education related to diagnostic services on several fronts including: the public, medical school students and residents, continuing medical education (CME), diagnostic imaging ordering systems that embed clinical practice guidelines (e.g., web-based computer order entry systems), as well as continuous audit and feedback of performance to clinicians.</li> <li>■ Support for the Ontario Health Technology Assessment Committee (OHTAC) should be continued, particularly for its recent and unique role in recommending field studies relating to diagnostic imaging technology. An application for OHTAC to examine obsolete and substitution diagnostic imaging technologies should be submitted.</li> <li>■ Trends in the ambulatory provision of imaging services by non-radiologists should be monitored, and key stakeholders should be involved in the creation of clear guidelines regarding self-referral for diagnostic imaging.</li> </ul>
<p>Matowe, L. et al. Effects of Mailed Dissemination of the Royal College of Radiologists' Guidelines on General Practitioner Referrals for Radiography: a Time-Series Analysis. <i>Clinical Radiology</i>. Vol 57. 575-578. 2002.</p>	<p>The study evaluated the effect of postal dissemination of the third edition of the Royal College of Radiologists' (RCR) guidelines on general practitioner referrals on radiography.</p> <p>An interrupted time series using monthly data for 34 months before and 14 months after dissemination of the guidelines was used. Data were abstracted for the period April 1994-March 1998 from the computerized administrative systems of open access radiological services provided by two teaching hospitals in one region of Scotland. The time series results are contrasted with those obtained by using simple before and after design.</p>	<p>A total of 117,147 imaging requests from general practice were received in two departments. There were no significant effects of disseminating the guidelines on the total number of requests, or on requests for individual examinations. If a simple before and after study had been used, then the study would have erroneously concluded that significant changes had occurred in referral practice for 11 of the 18 procedures concerned.</p> <p>Mailing copies of RCR's guidelines had a small effect on general practitioners' use of x-ray investigations of uncertain clinical significance. Additional dissemination and implementation strategies appear necessary to promote the use of guidelines.</p>
<p>Moskowitz, H. et al. The Effect of Imaging Guidelines on the Number and Quality of Outpatient Radiographic Examinations. <i>American Journal of Radiology</i>. Vol 175. 2000.</p>	<p>A significant percentage of outpatient diagnostic radiology is performed by non-radiologists. Studies have shown non-radiologists have higher utilization and cost, as well as quality problems. The study seeks to determine if, in a managed care environment, a set of guidelines limiting imaging privileges of non-radiologist physicians could</p>	<p>The number of radiographic examinations per 1000 enrollees decreased 20–25% from the previous trend. Non-radiologists' share of the total fell from 39% to 15%. No deficiencies were found in the inspection of five radiologists' offices, whereas significant deficiencies of equipment, equipment maintenance, or documentation of the examinations performed were found in 78% of non-radiologists' offices. None of the quality indicators monitored by the health plan showed significant change.</p>

	<p>decrease imaging costs while ensuring that equipment and personnel providing imaging were of the highest quality.</p> <p>The study determined the number and type of radiographic imaging studies performed the year after these guidelines were set in place (1997) and compared these findings with those of the year before the guidelines were established (1995) and with pre-guideline trends.</p>	<p>Specific guidelines can effect change in the location and number of radiologic examinations performed, with an improvement in the quality of the studies and a decrease in radiation dose and cost. No decline in quality of care appears to result despite claims by opponents to such changes that widespread serious quality impairment would occur.</p>
<p>National Institutes of Health. Image Guided Interventions. Department of Health and Human Services, USA. September 2006.</p>	<p>Fact sheet from the United States Department of Health and Human Services providing an overview of image guided interventions.</p>	<p>Today, three-dimensional biomedical images are being used for diagnosis, for planning and conducting treatment strategies and surgeries, and for undertaking image-guided interventions.</p> <p>In the future, advances in computer technology, coupled with an increase in the accuracy and sensitivity of imaging technologies, will make it possible to seamlessly integrate diagnosis and treatment. Future image-guided interventions will enable medical practitioners to detect critical illnesses at their most curable stage – oftentimes at the cellular level, before any symptoms or signs are noticeable. The practice of medicine will shift from one of disease detection and treatment to one of prediction and prevention in asymptomatic, at-risk populations.</p>
<p>Sanders, Jill. Challenges, Choices and Canada. <i>International Journal of Technology Assessment and Health Care</i>. Vol 18:2. 199-202. 2002.</p>	<p>The Canadian Coordinating Office for Health Technology Assessment (CCOHTA) was established by the Federal, Provincial, and Territorial Ministers of Health in 1989 for a 3-year trial period. In 1993 CCOHTA was made a permanent organization and in 1999 the Deputy Ministers of Health renewed CCOHTA’s mandate and increased its funding. CCOHTA’s role is to coordinate health technology assessment (HTA) priorities across jurisdictions, foster and undertake assessment activity, and function as a clearinghouse for technology assessment results and increase stakeholder awareness of HTA findings.</p>	<p>Conducting HTA in a healthcare system that serves many jurisdictions of widely varying sizes and geography is challenging. Effectively reaching decision makers is difficult in a broadly distributed decision-making system with a federal Department of Health plus 10 provincial and three territorial Ministries of Health.</p> <p>The coordinated and collaborated approach adopted by CCOHTA minimizes duplication with other national and provincial organizations and contributes to the ability of the Canadian healthcare system to continue to deliver high-quality health care to its constituents.</p>

**Patient Safety/Risk of Harm**

Authors, Title and Publication	Context/Type of Document	Main Findings/Recommendations
<p>Aldrich, J. et al. Radiation Doses to Patients Receiving Computed Tomography Examinations in British Columbia. <i>Canadian Association of Radiologists Journal</i>. Vol 57: 2. April 2006.</p>	<p>This article estimates the diagnostic reference levels and effective radiation dose to patients from routine computed tomography (CT) examinations in the province of British Columbia.</p> <p>Patient weight, height and CT dose index or dose linear product (DLP) were recorded on study sheets for 1070 patients who were referred for clinically indicated routine CT examinations at 18 radiology departments in British Columbia. Sixteen of the scanners were multidetector row scanners.</p>	<p>Among hospitals, there was considerable variation in the DLP and patient radiation dose for a specific exam. Reference doses and patient doses were higher than those found in similar recent studies in the United Kingdom and the European Union. Patient doses were similar to those found in a recent survey in Germany.</p> <p>The average patient dose varied from hospital to hospital. The largest range was found for CT of the abdomen (3.6 to 26.5, average 10.1 mSv); for head CT, the range was 1.7 to 4.9 (average 2.8) mSv; for chest CT: 3.8 to 26 (average 9.3) mSv; for pelvis CT: 3.5 to 15.5 (average 9.0) mSv; for abdomen-pelvis CT: 7.3 to 31.5 (average 16.3) mSv.</p>
<p>Bairstow, P.J. et al. Diagnostic Imaging Pathways: Development, Dissemination, Implementation and Evaluation. <i>International Journal for Quality in Health Care</i>. Vol 18:1. 51-57. 2005.</p>	<p>Imaging pathways were distributed via a hospital local area network and on compact disk. A multifaceted approach was used to raise general awareness of the pathways, followed by intensive 'marketing' activities. Two groups of clinicians were targeted; hospital-based clinicians and general practitioners.</p>	<p>There was increased awareness of imaging pathways. Clinicians judged them to be useful for education and decision support. The method of electronic delivery was adequate. Knowledge of diagnostic imaging and requesting behavior tended to become more aligned with the pathways. The central objective to reduce inappropriate medical imaging seems to be achievable.</p> <p>There is scope to improve the content and the electronic environment, achieve better integration into decision-making processes, and achieve better compliance. A linkage between imaging pathways and electronic requesting could provide alerts to 'non-compliant' requesting. The assignment of a higher cost, or a lower remuneration, to non-authorized and non-compliant imaging would provide tangible incentive to comply, unless there are compelling clinical contraindications.</p>
<p>Brealey, Stephen. Measuring the Effects of Image Interpretation: An Evaluative Framework. <i>Clinical Radiology</i>. Vol 56. 2001.</p>	<p>This paper is to delineate a basic framework for evaluating the overall impact of film reporting when choosing between alternative health care professionals.</p>	<p>Despite a growing literature of studies that evaluate the film reading performance of different health care professionals, there is a paucity of evidence of the subsequent effects on the referring clinician's diagnosis, management plans and patient outcome. This paper proposes an evaluative framework that can be used to measure the chain of events from the initial technical assessment of observers' potential to interpret images using search behaviour techniques, through to the potential costs and benefits to society. Evaluating the wider implications of alternative or complementary reporting policies is essential for generating the evidence base to comprehensively underpin policy and practice and direct future research.</p>

<p>Hammett, R. Harris, R. Halting the Growth in Diagnostic Testing. <i>The Medical Journal of Australia</i>. Vol 177:3. 124-125. 2002.</p>	<p>Editorial in an academic medical journal.</p> <p>The complexity of modern medicine has promoted an excessive reliance on the results of empirical tests rather than clinical acumen. In Australia, this is reflected in the fact that the rise in the costs of diagnostic testing in pathology and radiology is second only to the rise in cost of pharmaceutical prescriptions, the fastest-growing sector in the healthcare budget.</p>	<p>Many reasons have been cited for the increase in clinicians' reliance on pathology and radiology testing. Among community-based practitioners, ordering patterns are most likely to be influenced by medico-legal concerns, time constraints, screening needs, or ingrained practice habits. Among hospital-based clinicians, test-ordering practice may be determined by level of clinical experience, fear of censure for lack of testing, medico-legal concerns, and the desire to provide a "one-stop" service to evaluate all possible physiological parameters. In addition, the pressures of shorter consultation times in community practice and diminishing hospital beds have led to the increased use of investigations to fast-track patient throughput.</p> <p>The development of practical, sustainable means of improving the appropriateness of testing is needed. Future research should focus on understanding the place of sophisticated decision-analysis models, the role of point-of-care guidance and feedback systems, and effective clinical change-management strategies. A coordinated, multifaceted, sustained approach to this problem is required to achieve lasting success.</p>
<p>Lee, C. et al. Diagnostic CT Scans: Assessment of Patient, Physician, and Radiologist Awareness in Radiation Dose and Possible Risks. <i>Radiology</i>. Vol 231: 393-298. 2004.</p>	<p>To determine the awareness level concerning radiation dose and possible risks associated with computed tomographic (CT) scans among patients, emergency department (ED) physicians, and radiologists.</p> <p>Adult patients seen in the ED of a U.S. academic medical center during a 2-week period with mild to moderate abdominopelvic or flank pain and who underwent CT were surveyed after acquisition of the CT scan. Patients were asked whether or not they were informed about the risks, benefits, and radiation dose of the CT scan and if they believed that the scan increased their lifetime cancer risk. Patients were also asked to estimate the radiation dose for the CT scan compared with that for one chest radiograph. ED physicians who requested CT scans and radiologists who reviewed the CT scans were surveyed with similar questions and an additional question regarding the number of years in practice. The <math>\chi^2</math> test of independence was used to compare the three respondent groups regarding perceived increased cancer risk from one abdominopelvic CT scan.</p>	<p>Seven percent (five of 76) of patients reported that they were told about risks and benefits of their CT scan, while 22% (10 of 45) of ED physicians reported that they had provided such information. Forty-seven percent (18 of 38) of radiologists believed that there was increased cancer risk, whereas only 9% (four of 45) of ED physicians and 3% (two of 76) of patients believed that there was increased risk. All patients and most ED physicians and radiologists were unable to accurately estimate the dose for one CT scan compared with that for one chest radiograph.</p> <p>Patients are not given information about the risks, benefits, and radiation dose for a CT scan. Patients, ED physicians, and radiologists are unable to provide accurate estimates of CT doses regardless of their experience level.</p>

<p>McCollough, C. et al. CT Dose Reduction and Dose Management Tools: Overview of Available Options. <i>Radiographics</i>. Vol 26:2. March-April 2006.</p>	<p>As the growth in CT utilization increased, particularly in paediatric patients, and as concern about the population dose from CT began to be expressed in the scientific literature and media, it became clear that the responsible use of CT required an adjustment of technique factors on the basis of patient size (attenuation characteristics). While there are additional technical mechanisms for dose reduction at CT, this review is focused only on tube current modulation and patient size-dependent tube current adaptation, two mechanisms that are jointly referred to as automatic exposure control (AEC).</p>	<p>AEC systems in which the tube current is modulated along the x-, y-, and z-axes and in which the acceptable level of image noise is varied according to patient size, anatomic region, and diagnostic task can provide significant levels of dose reduction with minimal operator intervention. Even systems that offer only a subset of these features provide meaningful levels of dose reduction. In the future, the expectation is that the use of AEC systems will become mandatory and that such systems will be available on all CT scanners. The article strongly encourages users to take advantage of these technical mechanisms for reducing radiation dose while maintaining diagnostic image quality.</p>
<p>Mendelson, R. and Murray, C. Towards the Appropriate Use of Diagnostic Imaging. <i>The Medical Journal of Australia</i>. Vol 187: 1. 5-6. 2007.</p>	<p>Editorial in academic medical journal.</p>	<p>A lack of understanding of the role of imaging in specific clinical circumstances leads to unnecessary imaging or imaging that is inappropriate in terms of timing or the choice of modality.</p> <p>Referring GPs need to be educated on imaging technology and imaging guidelines based on evidence and expert consensus need to be disseminated, 'marketed' and made easily accessible. Such guidelines would enable referrers to answer specific questions in relation to clinical scenarios and individual patients. Radiologists must also take more responsibility for effective and appropriate use of imaging.</p>
<p>Mettler, F. et al. CT Scanning: Patterns of Use and Dose. <i>Journal of Radiological Protection</i>. Vol 20. 353-359. 2000.</p>	<p>CT scanning is a relatively high-dose procedure. In spite of the use of magnetic resonance imaging, with faster CT scanners and helical techniques CT is becoming more common. There are few data from practice in the United States regarding the age and sex distribution of patients receiving CT scans, what type of scan and how many scans they receive, or how much radiation dose CT scans contribute.</p> <p>The article reviews over 33,700 consecutive CT examinations done at The University of New Mexico Health Sciences Centre in 1998 and 1999. Information on the types of scans as well as the age and sex distribution of the patients was determined.</p>	<p>Between 1990 and 1999, CT examinations in the institution increased from 6.1% to 11.1% of all radiology procedures. Nineteen per cent of all patients seen in the department in the last year had at least one CT scan and more than half had multiple scans on the same day. Thirty-six per cent of all patients had a prior CT examination done on an earlier date. The male/female ratio of patients was 56/44. Studies of children age 0-15 years comprised 11.2% of scans. The highest percentage of scans was done in the 36-50-year-old age group. CT scanning accounted for 67% of the effective dose from diagnostic radiology.</p> <p>In most large hospitals in the United States, CT scanning probably accounts for more than 10% of diagnostic radiology examinations and about two-thirds of the radiation dose. Most patients have multiple scan sequences. Studies done on children are probably more common than previously thought.</p>

<p>Picano, E. Sustainability of medical imaging: doctors and patients should be more aware of the long term risks of radiological investigations. <i>British Medical Journal</i>. Vol 328. 2004.</p>	<p>This article outlines the effect of ionising testing in society, reviews the possible detrimental public health effect based on current estimates of risk, and discusses simple ways of achieving a more cautious approach.</p>	<p>Increased awareness among both doctors and patients is needed to reduce inappropriate medical imaging and the avoidable biological burden on current and future generations.</p> <p><u>Summary points:</u></p> <ul style="list-style-type: none"> <li>▪ Medical radiation from x-rays and nuclear medicine is the largest man-made source of radiation exposure in western countries;</li> <li>▪ Doctors are insufficiently aware of the long term health risks associated with radiological imaging. Long term risks are often ignored in cost effectiveness analysis of medical imaging;</li> <li>▪ Radiological awareness could be increased by auditing prescriptions and more explicit informed consent forms;</li> <li>▪ Journals should encourage reporting of radiation doses in papers.</li> </ul>
<p>Report of the Diagnostic Imaging Safety Committee for Computed Tomography (CT). February 2007.</p>	<p>The Ontario Health Technology Advisory Committee (OHTAC) recommended that a study of the safety aspects of computed tomography (CT) and magnetic resonance imaging (MRI) be conducted. The Ministry of Health and Long-Term Care (MOHLTC) provided a research grant to investigate and provide safety recommendations on CT and MRI for OHTAC's consideration. Recommendations from the two reports, covering CT and MRI safety, were endorsed by OHTAC. One of the recommendations was to create a Diagnostic Imaging Safety Committee for CT and MRI. The CT Safety Committee would be responsible for the development of recommendations concerning standards and best practices for CT, including methods of dose reduction to patients and medical imaging staff, as well as the testing and inspection of CT scanners in Ontario.</p>	<p>Key Recommendations:</p> <p><b>HARP Act</b></p> <ul style="list-style-type: none"> <li>▪ The HARP Act should be revised to include a definition of a "computed axial tomography (CT) scanner or machine." Future revisions to the HARP Act should also recognize that the radiation doses associated with CT examinations are generally higher than those associated with conventional x-ray examinations.</li> </ul> <p><b>Alternative Imaging Methods</b></p> <ul style="list-style-type: none"> <li>▪ The decision to perform a CT examination must be justified based on the clinical setting and is a shared responsibility between the referring clinician and the radiologist. Alternative imaging methods that do not use ionizing radiation — such as ultrasound (US) or magnetic resonance imaging (MRI) — should be considered if appropriate.</li> </ul> <p><b>Prescribing or Requesting a CT Scan</b></p> <ul style="list-style-type: none"> <li>▪ CT examinations should specifically be excluded from Medical Directives. The larger radiation doses generally associated with CT compared to those associated with conventional x-rays pose patient safety concerns in the use of Medical Directives for CT examinations.</li> <li>▪ The HARP Act should be revised to ensure that only individuals who have the appropriate clinical knowledge and training in radiation safety are permitted to prescribe or request CT examinations.</li> </ul> <p><b>Pregnancy</b></p> <ul style="list-style-type: none"> <li>▪ Each CT facility shall have a policy for screening women of childbearing age for pregnancy before performing a CT examination. If the patient is pregnant or possibly pregnant, the benefits of performing the CT must be weighed against any potential risk to the fetus.</li> </ul>

		<p><b>Patient Shielding</b></p> <ul style="list-style-type: none"> <li>▪ The Radiation Protection Officer (RPO) at each facility shall develop a policy for patient shielding specifically for CT. The policy should be appropriate for the facility's CT equipment and patient population, and comprise protocols for in-beam and out-of-beam shielding accessories. The policy should be reviewed on a regular basis, taking into consideration changes in practice and technological innovations.</li> </ul> <p><b>Anatomic Coverage</b></p> <ul style="list-style-type: none"> <li>▪ The anatomic coverage of a CT examination should be limited to the area of clinical interest.</li> </ul> <p><b>CT Protocols</b></p> <ul style="list-style-type: none"> <li>▪ CT protocols should be designed to obtain the necessary diagnostic information based on the clinical indication of each situation. CT protocols should be reviewed periodically by radiologists and CT technologists to ensure dose optimization.</li> </ul> <p><b>CT Scanning Parameters</b></p> <ul style="list-style-type: none"> <li>▪ CT technologists and radiologists must be knowledgeable about how the manipulation of various scanning parameters may influence dose and image quality in their CT scanners.</li> </ul> <p><b>Multiphase Image Acquisition</b></p> <ul style="list-style-type: none"> <li>▪ The acquisition of more than one set of images from the same anatomic region must be justified based on detailed medical and radiological knowledge.</li> </ul> <p><b>CT Manufacturers/Vendors</b></p> <ul style="list-style-type: none"> <li>▪ Upon installation of a new CT scanner, a facility's Radiation Protection Officer (RPO) shall provide the X-ray Inspection Service (XRIS) of MOHLTC proof that the technologists and physicians operating that specific make and model of CT scanner have received training on dose reduction strategies appropriate to the planned clinical operation of the scanner. This proof would be in the form of a certificate of training provided by the vendor. In addition, the RPO must keep a permanent record of authorized operators and their training status on installed CT scanners for review by MOHLTC and its enforcement agents for at least six years.</li> </ul> <p><b>Diagnostic Reference Levels</b></p> <ul style="list-style-type: none"> <li>▪ Ontario should establish Diagnostic Reference Levels for the following CT examinations: head CT, chest CT, and abdominal/pelvic CT. A team consisting of members from professional medical bodies should be established to review the methods for establishing DRLs, administer the survey, collect the data, determine the DRLs, and disseminate the information to all stakeholders. Once established, DRLs should be reviewed periodically. Funding that is appropriate to the scope of the project will be required.</li> <li>▪ Manufacturers of CT scanners (including Positron Emission Tomography/CT units) must display the dose for each CT examination on the</li> </ul>
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		<p>control console.</p> <ul style="list-style-type: none"> <li>▪ The dose for each CT examination must be recorded. This record must be kept and be available for periodic audit.</li> <li>▪ In paediatric cases, the size of the CT phantom used in calculating dose information must be displayed.</li> </ul> <p><b>Paediatric CT</b></p> <ul style="list-style-type: none"> <li>▪ All requests for CT examinations for children must be reviewed by a radiologist prior to booking to ensure that the referral is appropriate and that possible alternative imaging modalities have been considered.</li> <li>▪ Each CT facility must establish local protocols for use in paediatric scanning. The Radiation Protection Officer must demonstrate to MOHLTC that technologists and radiologists operating the CT scanner have received instruction on the appropriate use of paediatric protocols.</li> </ul> <p><b>CT Technologist Training</b></p> <ul style="list-style-type: none"> <li>▪ MOHLTC should continue to provide support for a standardized CT curriculum for all undergraduate/college Medical Radiation Technologist (MRT) programs and for access to the same curriculum for MRT graduates in Ontario.</li> <li>▪ The CT curriculum shall include training in radiation safety and dose management.</li> </ul> <p><b>CT Personnel and the Work Environment</b></p> <ul style="list-style-type: none"> <li>▪ In addition to existing legislation and policies, CT facilities shall adopt the following safety guidelines: <ul style="list-style-type: none"> <li>▪ Doors accessible to the general public that enter into a CT scan room must be locked during scanner operation.</li> <li>▪ CT operators must be within arm's length of the scan abort button during image acquisition.</li> <li>▪ CT operators must be in visual contact with the patient during image acquisition.</li> </ul> </li> </ul> <p><b>CT Scanner Testing and Inspection</b></p> <ul style="list-style-type: none"> <li>▪ The testing and inspection of CT scanners should be specifically incorporated into the HARP Act. This may require a major revision to the HARP Act and the X-ray Safety Code. The role and duties of the X-ray Inspection Service may also need to be modified so that XRIS is able to perform and audit the inspection and maintenance of CT scanners, including dental cone beam CT, in Ontario. The appropriate resources to expand this service will be necessary.</li> </ul> <p><b>Research</b></p> <ul style="list-style-type: none"> <li>▪ Close collaboration among CT manufacturers, imaging scientists, and radiologists is encouraged to further explore and promote methods of dose management for CT.</li> </ul>
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<p>Report of the Diagnostic Imaging Safety Committee for Magnetic Resonance Imaging (MRI). February 2007.</p>	<p>Objectives of this report were to describe how:</p> <ul style="list-style-type: none"> <li>▪ MRI facilities in Ontario will be <i>designed and constructed</i> in a manner that is conducive to the safe operation of the facilities, and that will reduce the risk of safety hazards to MR personnel, other health care workers, patients, and the general public;</li> <li>▪ MRI facilities in Ontario will be <i>operated, maintained and inspected</i> in a manner that will reduce the risk of safety hazards to MR personnel, other health care workers, patients, and the general public.</li> <li>▪ Context: The Ontario Health Technology Advisory Committee (OHTAC) recommended that a study of the safety aspects of computed tomography (CT) and magnetic resonance imaging (MRI) be conducted. Recommendations from the resulting two reports, covering CT and MRI safety, were endorsed by OHTAC. One of the recommendations was for MOHLTC to create a Diagnostic Imaging Safety Committee (DISC) for CT and MRI. The MR Safety Committee would be responsible for developing recommendations concerning standards and best practices for MR, including facilities' physical requirements, testing and inspection of MR scanners and facilities in Ontario, and education and training of relevant health care workers.</li> </ul>	<p><u>Key Recommendations</u></p> <p><b>Design and construction</b></p> <ul style="list-style-type: none"> <li>▪ All MRI facilities shall be designed and constructed in a manner that recognizes the potential safety hazards associated with the area around an MR scanner. In particular, all MRI facilities shall restrict access to MR safety zones (Zones III and IV) to only MR personnel, patients and research subjects under the direct supervision of MR personnel, and appropriately trained MR research personnel.</li> <li>▪ All proposals for new MRI facilities should be reviewed by the province of Ontario to ensure that their design and operation plans meet the criteria set out in this report, prior to receiving approval and licensing from the province.</li> </ul> <p><b>Inspection</b></p> <ul style="list-style-type: none"> <li>▪ Upon completion of construction, the province should inspect the MRI facilities to ensure that they meet the criteria set out in this report, prior to approving the start of operations.</li> <li>▪ All MRI facilities shall be inspected for adherence to the policies and practices described in this report as soon as is possible after acceptance of this report, and then no less frequently than every five years thereafter. If a facility does not satisfy the policies and practices set forth in this report, the facility should be advised by the province to remedy its deficiencies or risk losing its MRI facility license.</li> </ul> <p><b>Policies and procedures</b></p> <ul style="list-style-type: none"> <li>▪ Each MRI facility shall have an <b>MR Safety Officer</b> whose responsibilities will include ensuring that MR safe practice guidelines are established, implemented, maintained, and routinely reviewed and updated as necessary.</li> <li>▪ The level of <b>compliance</b> of an MRI facility's staff to its MR safety policies and procedures shall be assessed and documented annually. This will be the responsibility of the facility's MR Safety Officer. The policies and procedures manual should be on site and readily available to MR professionals and to agents of the Ministry of Health and Long-Term Care or of other regulatory bodies at all times of operation.</li> <li>▪ MR safety policies and procedures shall be reviewed concurrently with the introduction of any significant changes to the safety parameters of the MR environment of the site and modified as needed. (See page 12)</li> <li>▪ Each MRI facility shall develop a <b>screening</b> process and a screening form for the purpose of ascertaining which workers, patients, or other members of the public are at risk from being in or near the MRI facility.</li> <li>▪ Each MRI facility shall have procedures in place to ensure that any and all <b>adverse events</b> or MR safety incidents (or "near incidents") that occur in the facility are reported to the MR Medical Director or MR Safety Officer in a</li> </ul>
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		<p>timely manner.</p> <ul style="list-style-type: none"> <li>▪ The province should develop a process to gather reports of adverse events and “near misses” from all MRI facilities in the province, and make these known on a regular basis across all Ontario MRI facilities.</li> </ul> <p><b>Certification</b></p> <ul style="list-style-type: none"> <li>▪ MR scans of human patients and human research subjects shall be performed only by CMRTO registered MR technologists or by medical doctors with specific training in MR. If the latter, the medical doctor shall have training in MR safety that is at least equal to the MR safety training received by Level 2 MR personnel. Students in an accredited program may perform MR scans if they are under the supervision of a CMRTO registered MR technologist. MR scans of animals and/or inanimate objects may be performed by CMRTO registered MR technologists or by other appropriate medical, scientific, or service personnel, provided they have been adequately trained in MR safety.</li> </ul> <p><b>MR personnel</b></p> <ul style="list-style-type: none"> <li>▪ Each MRI facility shall train and designate Level 1 and Level 2 MR personnel. All other persons shall be designated as non-MR personnel. Non-MR personnel will be prohibited from gaining access to MR safety zones unless accompanied by MR personnel.</li> </ul> <p><b>Screening: humans</b></p> <ul style="list-style-type: none"> <li>▪ Each MRI facility shall develop and implement a screening process and screening form for patients and other non-MR personnel. In particular, policies and procedures must exist and be followed for: emergency response personnel such as police and firefighters; objects carried on or in the bodies of non-MR personnel; and the monitoring of patients’ vital signs while they are in the MR scanner.</li> </ul> <p><b>Screening: devices and objects</b></p> <ul style="list-style-type: none"> <li>▪ Each MRI facility shall develop and implement a screening process for all devices and objects that may be introduced into MR safety zones. The MR safety or MR compatibility of any device or object must never be assumed. All unknown, external objects and devices must be tested and labelled before being brought into an MR safety zone.</li> </ul> <p><b>Other safety issues</b></p> <ul style="list-style-type: none"> <li>▪ Each MRI facility shall develop and implement policies concerning the following: pregnancy related issues; time-varying gradient magnetic field-related issues; and cryogen-related issues.</li> </ul> <p><b>Public education</b></p> <ul style="list-style-type: none"> <li>▪ The province should produce public education materials that explain the basic function and design of MR scanners and the risks posed to those who are in or near such scanners, whether as patients, accompanying persons, or personnel.</li> </ul>
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<p>Schaefer-Prokop, C. et al. Digital Chest Radiography: an update on modern technology, dose containment and control of image quality. <i>European Radiology</i>. Vol 18: 1818-1830. 2008.</p>	<p>The introduction of digital radiography has revolutionized communication between radiologists and clinicians, improved image quality, and allowed for further reduction of patient exposure. However, digital radiography also poses risks, such as unnoticed increases in patient dose and suboptimum image processing that may lead to suppression of diagnostic information.</p>	<p>This review summarizes the most recent technical developments with regard to new detector techniques, options for dose reduction and optimized image processing. It explains the meaning of the exposure indicator or the dose reference level as tools for the radiologist to control the dose. It also provides an overview over the multitude of studies conducted in recent years to evaluate the options of these new developments to realize the principle of ALARA. The focus of the review is hereby on adult applications, the relationship between dose and image quality and the differences between the various detector systems.</p>
<p>Shiralkar, S. et al. Doctor's Knowledge of Radiation Exposure: Questionnaire Study. <i>British Medical Journal</i>. Vol 327. 371-372. 2003.</p>	<p>This article investigates, through a questionnaire, the level of knowledge doctors have concerning radiation doses received by patients when they undergo commonly requested radiological investigations.</p>	<p>Overall, 97% of the answers were underestimates of the actual dose. 5% of doctors did not realize that ultrasound does not use ionizing radiation, and 11% did not realize that magnetic resonance imaging does not use ionizing radiation.</p>
<p>Simpson, G. and Hartrick, G. Use of Thoracic Computed Tomography by General Practitioners. <i>Medical Journal of Australia</i>. Vol 187. 43-46. 2007.</p>	<p>This paper audits requests for computed tomography (CT) examination of the chest emanating from general practitioners and assess the appropriateness and usefulness of these requests.</p> <p>The study reviewed 50 consecutive requests for CT examination received by two private radiology practices in Cairns between August 2004 and March 2005. Clinical details were abstracted from request forms and clarified by telephone if necessary. A subjective assessment of the appropriateness of the investigation was made by the authors. The study was performed in a large regional centre. The main outcome measures were indications for requesting a CT scan and appropriateness of CT scan for indication specified.</p>	<p>Fifteen patients had had recent normal chest x-rays, all of whom proved to have normal CTs; eight had not had a recent chest x-ray performed. The CT scan was considered appropriate in 16 cases (32%), but 10 of these patients required referral to specialists anyway. Thirty-four CT scans (68%) were felt to be inappropriate and, of these, 10 were subsequently referred to specialists. In only six cases did the CT scan resolve the GP's clinical problem. In six cases the wrong type of CT scan was performed (five were conventional CT scans instead of high-resolution scans; one was a high-resolution instead of low-resolution scan).</p> <p>Many CT examinations of the chest requested by GPs could be avoided or replaced by simpler, cheaper tests with lower radiation exposure. Assuming a fatal cancer risk of 1 in 3000, the radiation exposure involved in unnecessary chest CT scans could be responsible for about 40 fatal cancers a year in Australia.</p>

<p>Thomas, K. et al. Assessment of Radiation Dose Awareness Among Paediatricians. <i>Paediatric Radiology</i>. Vol 36. 823-832. 2006.</p>	<p>This article aims to establish the level of awareness among paediatricians of recent publicity on radiation risks in children, knowledge of the relative doses of radiological investigations, current practice regarding patient/parent discussions and the sources of educational input through a multiple choice survey.</p>	<p>There is an increasing awareness among paediatric radiologists of the potential risks associated with ionizing radiation in medical imaging. However, whether there has been a corresponding awareness in paediatricians is unknown.</p> <p>Awareness of radiation protection issues among paediatricians is generally low, with widespread underestimation of relative doses and risks. Of 220 responses, 48% were aware of articles on paediatric CT and radiation, though only 6% were correct in the quoted lifetime excess cancer risk associated with radiation doses equivalent to paediatric CT. When estimating the doses of various paediatric radiological investigations in the chest radiograph (CXR) equivalents, 87% of all responses were underestimates. Only 15% were familiar with the ALARA principle. Only 14% of paediatricians recalled any relevant formal teaching during their specialty training.</p>
<p>Whitton, A. et al. Organizational Standards for the Delivery of Intensity Modulated Radiation Therapy (IMRT) in Ontario: Recommendations. Developed by the Expert Panel on Intensity Modulated Radiation Therapy. Program in Evidence-Based Care: A Cancer Care Ontario Program. A Special Project of the Radiation Treatment Program, Cancer Care Ontario and the Program in Evidence-based Care, Cancer Care Ontario. January 30, 2008.</p>	<p>The Radiation Therapy Evidence-based Series are produced by Expert Panels convened by Cancer Care Ontario (CCO) that work together with the Program in Evidence-Based Care to gather and examine evidence on specific topics related to radiation therapy treatment in Ontario.</p> <p>Evidence on organizational issues of IMRT delivery was gathered through a systematic search of the published literature and a scan of documents from key national and international organizations, cancer treatment centres, and insurance companies, as well as IMRT technology vendors in Canada, the United States, Australia, and Europe. Evidence was reviewed by members of the IMRT Expert Panel, which included representation from radiation oncology, radiation therapy, medical physics, nursing, and Cancer Care Ontario's Radiation Treatment Program, Capital Projects Office, and Program in Evidence-based Care. The IMRT standards were developed using a combination of evidence-based analysis, existing guidance documents and recommendations, and expert opinion based on experience and consensus.</p>	<p>This report, created by the CCO IMRT Expert Panel, presents organizational standards for the delivery of IMRT in an Ontario Cancer Program. These standards apply to all institutions and hospitals delivering IMRT within the province, and address the following domains: the planning of new IMRT programs, practice setting requirements, tools, devices and equipment requirements; professional training requirements; the role of personnel; and requirements for quality assurance and safety. These standards are based on a synthesis of a systematic review of the evidence and on the consensus opinion of the IMRT Expert Panel.</p> <p>The panel's goal is to raise the standard of care around IMRT provision and to accommodate the long-range needs of the province. This includes the ability to adapt to the projected increase in demand for IMRT over the next decade to reflect not only an advancing global standard of care, but also a growing and aging population in Ontario.</p> <p>The document includes standards for:</p> <ul style="list-style-type: none"> <li>▪ Implementation of an IMRT Program</li> <li>▪ Practice Setting</li> <li>▪ Tools, Devices and Equipment Requirements</li> <li>▪ Professional Training Requirements</li> <li>▪ Quality Assurance and Safety</li> </ul>