



## **ONTARIO BEST PRACTICE GUIDELINES FOR MANAGING THE FLOW OF PATIENTS REQUIRING AN MRI OR CT EXAMINATION**

**– Effective as of May 28, 2009 –**

This document was developed to assist radiologists, medical radiation technologists, administrators, physicians and other clinicians to establish and manage effective, efficient and safe MRI and CT programs.

The guidelines were developed after extensive review by a broad range of expert clinical and administrative leaders. The guidelines are supported with available evidence, and were informed by the work of Ontario's MRI and CT Expert Panel.

These best practice guidelines are effective as of May 28, 2009 and will be reviewed and updated, as required.

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## INTRODUCTION

Timely access to Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) is a fundamental part of Ontario's Wait Time Strategy. The demand for MRI and CT scans is growing as the clinical indications for these procedures increase. MRI and CT scans are being routinely used in cancer care to help diagnose disease, determine appropriate treatment and for routine follow-up. MRI and CT make up a significant proportion of the diagnostic imaging procedures performed in Ontario's hospitals. The use of best practice guidelines to manage the flow of patients who need an MRI and CT will help improve timely access to these diagnostic scans as well as to other procedures that depend on the results of an MRI or CT scan.

The purpose of this document is to assist radiologists, medical radiation technologists, administrators, physicians and other clinicians to establish and manage effective, efficient and safe MRI and CT programs. The document presents best practice guidelines for managing the flow of emergency and elective MRI and CT patients, and includes best practices for program accountability. The flow of patients includes a number of well-defined stages beginning with the decision to request an MRI or CT examination to communicating the results to the referring physician (Figure 1).

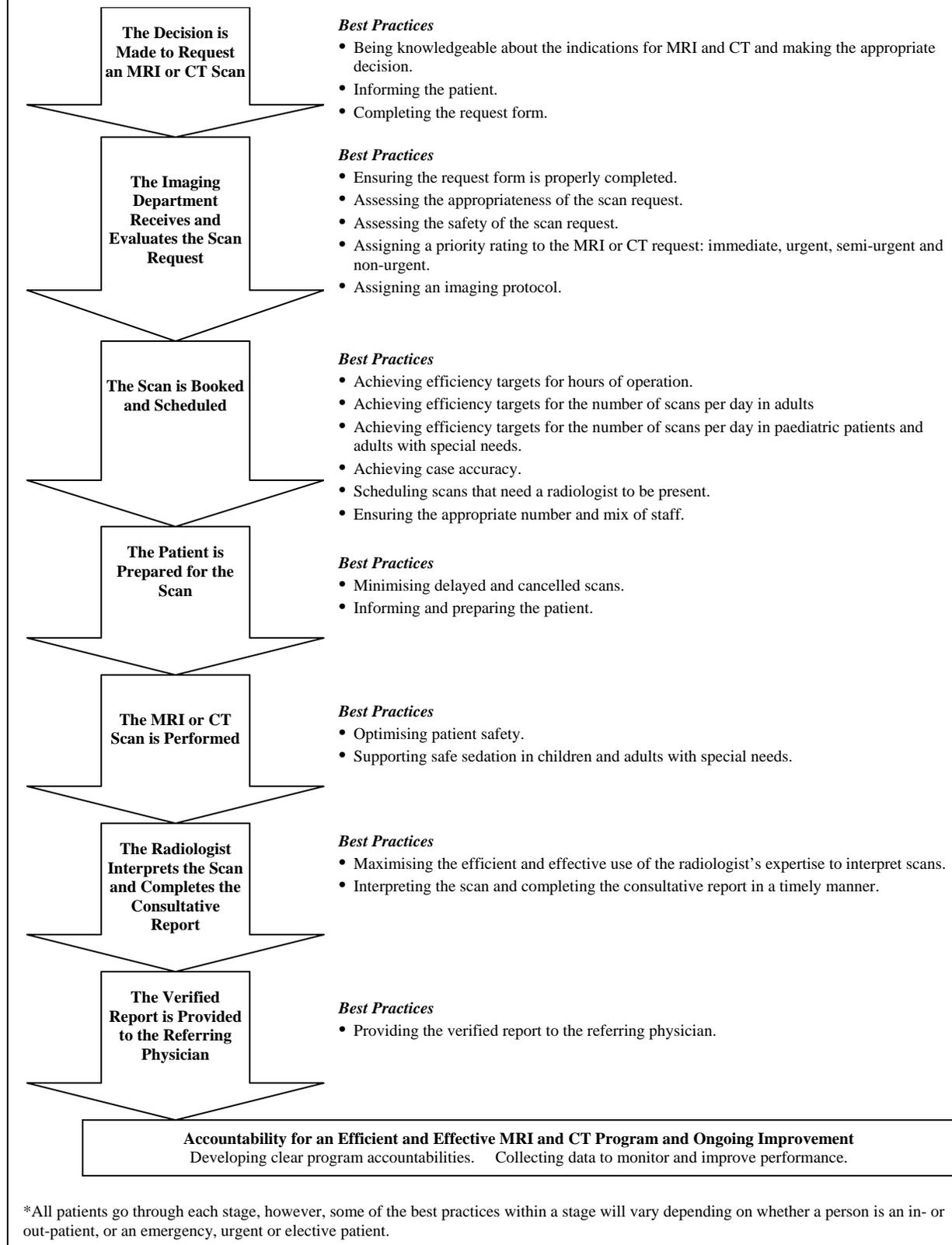
This document was developed using the following process.

- A small working group developed a preliminary draft.
- The preliminary draft was extensively reviewed by a broad range of expert clinical and administrative leaders (Appendix A).
- The working group reviewed the comments of the expert reviewers along with available evidence, and developed the final best practice guidelines document.

The guidelines were informed by the excellent work of the provincial MRI and CT Expert Panel which was established by the Ministry of Health and Long-Term Care to advise government on improving access to MRI and CT.<sup>1</sup>

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<sup>1</sup> MRI and CT Expert Panel (Anne Keller, Chair). 2005 (April). *MRI and CT Phase I Report*; MRI and CT Expert Panel (Anne Keller, Chair). 2006 (December 4). *MRI and CT Phase II Report*.

**Figure 1: Process Map For Patients Requiring an MRI or CT\***

## BEST PRACTICES FOR MANAGING PATIENT FLOW

### 1. THE DECISION IS MADE TO REQUEST AN MRI OR CT SCAN

#### Preamble

General practitioners can request MRI and CT scans depending on the hospital; specialists can also request both types of scans at all hospitals.<sup>2</sup> There is evidence to suggest that referring physicians – specialists and non-specialists – are not sufficiently informed about the appropriate clinical use of MRI and CT and may order these scans inappropriately. For example, a recent chart abstraction study funded by Ontario’s Wait Time Strategy found considerable and unexpected variations in ordering practices between hospitals.<sup>3</sup> The review of over 11,800 CTs and 11,800 MRIs performed on Ontario outpatients found: i) as much as a 70-fold difference between hospitals in the frequency of scans ordered for a specific indication; ii) less than 2% of CT scans of the brain for headache had abnormalities that could explain the headache; and iii) although over 90% of MRI scans of the spine for back pain were abnormal, the clinical importance of the abnormalities was unclear. Although the researchers note that negative scans have value in ruling out disease, they conclude that many patients with a very low pre-test probability of disease can be reassured without performing a scan.

In addition to receiving some training about diagnostic imaging in medical school, general practitioners (GPs) and specialists who request MRIs and CTs can benefit from continuing education courses on the appropriate use of medical imaging scans based on common clinical scenarios. Guidelines can also be used to help referring physicians determine appropriateness. For example, the American College of Radiology (ACR) provides a broad range of practice guidelines, technical standards and appropriateness criteria developed through consensus and review, to assist clinicians ([www.acr.org](http://www.acr.org)). The Canadian Association of Radiologists also has ordering guidelines (see [www.car.ca](http://www.car.ca) for: The Canadian Association of Radiologists. 2005. *Diagnostic Imaging Referral Guidelines: A guide for physicians*).

Research has shown that the use of these guidelines impacts positively on the appropriate use of MRI and CT. For example:

- One study evaluating the effects and applicability of the ACR Appropriateness Criteria by non-radiologist physicians in an MRI preauthorization centre, found an increase in the rate of appropriate MRI exams and a decrease in the rate of

<sup>2</sup> Iron K, Przybysz R, Laupacis A, *Access to MRI in Ontario: Addressing the Information Gap*. Toronto: Institute for Clinical Evaluative Sciences, 2003.

<sup>3</sup> You, J.J., I. Purdy, D. Rothwell, R. Przybysz, J. Fang and A. Laupacis. 2008 (June). “Indications For and Results of Outpatient Computed Tomography and Magnetic Resonance Imaging in Ontario” *Canadian Association of Radiologists Journal* 59(3): 135-143.

inappropriate MRI exams.<sup>4</sup> In this study, ACR Appropriateness Criteria were applicable to about 50% of MRI requests.

- A second study of the use of CT and MRI after implementing a preauthorization program based on the ACR Appropriateness Criteria and the guidelines of the Royal College of Radiologists (United Kingdom) found that the number of MRIs and CTs decreased substantially.<sup>5</sup> This resulted in reduced imaging costs.

An electronic order entry system for MRI and CT that incorporates indications for these scans would be ideal. Since such a system does not exist in Ontario, GPs and specialists who are considering whether to order an MRI or CT scan must answer two fundamental questions: 1) are there appropriate indications for ordering the scan; and 2) can the patient have the scan safely? Once these questions are answered, the patient or substitute decision maker needs to be fully informed about, and provide his or her consent to have, the scan. The referring physician then needs to complete the requisition and screening forms correctly.

Best practice guidelines to support the decision to order an MRI or CT scan include:

- Being knowledgeable about the indications for MRI and CT and making the appropriate decision.
- Informing the patient.
- Completing the request form.

### **Being Knowledgeable About the Indications for MRI and CT and Making the Appropriate Decision**

- 1.1 The *referring* physician will be knowledgeable about the indications for an MRI or CT scan and will order the scan only when appropriate. The physician's knowledge should include training on the appropriate use of MRI and CT and the use of best practice guidelines (e.g., American College of Radiology, Canadian Association of Radiologists). (See Appendix B, *Physician Education and Knowledge When Ordering an MRI or CT.*)
- 1.2 The *referring* physician will be fully aware of the patient's medical history and any contraindications that might impact on the patient safely receiving an MRI or CT. Where necessary, the referring physician will perform the appropriate tests to inform his or her decision (e.g., blood work). See the Canadian Association of Radiologists for standards for CT and MRI scans.<sup>6</sup>

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<sup>4</sup> Levy, G. et al. 2006 (October). Nonradiologist utilization of American College of Radiology Appropriateness Criteria in a Preauthorization Center for MRI Requests: Applicability and Effects" *American Journal of Radiology* 187: 855-858.

<sup>5</sup> Blacher, A. et al. 2006. "Preauthorization of CT and MRI Examinations: Assessment of a Managed Care Preauthorization Program Based on the ACR Appropriateness Criteria and the Royal College of Radiology Guidelines". *Journal of the American College of Radiology* 3: 851-859.

<sup>6</sup> [www.car.ca/Files/ct\\_scans.pdf](http://www.car.ca/Files/ct_scans.pdf) and [www.care.ca/Files/mri.pdf](http://www.care.ca/Files/mri.pdf)

## **Informing the Patient**

- 1.3 The *referring* physician will describe to his or her patient (or substitute decision maker) what an MRI or CT scan is and how it is performed, the benefits and risks of the procedure, and how the patient may benefit from the examination. The *referring* physician will ensure that the patient (or substitute decision maker) has sufficient information to proceed knowledgeably with the scan. (See Appendix C, *Information for Patients on MRI and CT.*)
- 1.4 The physician who gives the order for an MRI or CT scan is responsible for assessing the capacity of the patient and obtaining informed consent for the scan, in most circumstances (see 4.3).

## **Completing the Request Form**

- 1.5 The *referring* physician will complete and sign the requisition and screening forms required by the receiving hospital for an MRI or CT scan, appropriately assess the patient's urgency for a scan, and provide all necessary information to support the request (e.g., blood work results, contraindications, previous relevant examinations).
- 1.6 The *referring* physician will refrain from sending out requests for an MRI or CT scan to multiple hospitals simultaneously.

## **2. THE IMAGING DEPARTMENT RECEIVES AND EVALUATES THE SCAN REQUEST**

### **Preamble**

When the hospital imaging department receives a request for an MRI or CT scan, imaging personnel need to evaluate the scan request using best practices in the following areas:

- Ensuring the Request Form is Properly Completed
- Assessing the Appropriateness of the Scan Request
- Assessing the Safety of the Scan Request
- Assigning a Priority Rating to the MRI or CT Request: Immediate, Urgent, Semi-Urgent and Non-Urgent
- Assigning an Imaging Protocol

### **Ensuring the Request Form is Properly Completed**

- 2.1 The booking personnel (e.g., booking clerk, scheduler, etc.) will review the request for an MRI or CT to ensure that the form is completed properly and legibly signed by the referring physician, contraindications are identified and all

- supporting information is provided. This may include basic client identifiers (e.g., name, health number, date of birth, gender), name of the most responsible physician, names of other medical professional(s), all relevant clinical information, type of procedure and special instructions.
- 2.2 If a request for an MRI or CT is made by telephone, the booking personnel (e.g., booking clerk, scheduler, etc.) will collect and record the information and proceed to book the case. The scan will not be performed until a written requisition form signed by the referring physician is received (fax, mail, electronic-mail).
- 2.3 If the request for an MRI or CT scan is incomplete, the booking personnel (e.g., booking clerk, scheduler, etc.) will contact the referring physician for the additional information or, if appropriate, interview the patient to obtain the necessary information.

### **Assessing the Appropriateness of the Scan Request**

- 2.4 The radiologist will review the scan request to assess whether an MRI or CT scan is appropriate. The radiologist will assess whether an MRI or CT scan is justified given the patient's pertinent clinical information, and whether the scan can be performed safely. If, in the radiologist's professional opinion, an MRI or CT scan is inappropriate, he or she will contact the referring physician to discuss the issue and alternative courses of action.
- 2.5 Hospitals will develop clear operating policies outlining when an MRI or CT scan can be performed without the requisition being first reviewed by the radiologist (e.g., cancer follow-up).

### **Assessing the Safety of the Scan Request**

- 2.6 All patients referred for an MRI or CT scan will be screened to ensure that the scan can be done safely and with minimal risk to the patient. This includes, but is not limited to, the following considerations:
- The patient is pregnant and there is potential risk to the fetus.
  - The patient has an implanted device, and the radiologist or technologist must confirm that the device can safely go through the magnetic field of the MRI scanner.
  - The patient has an external electronic device that is contraindicated for MRI (e.g., Holter monitor).
  - The possibility of metallic foreign bodies needs to be excluded by ordering and reviewing X-rays (e.g., orbit).
  - Patients who need IV contrast need to be screened to ensure the contrast can be injected safely and that potential risks are minimised (e.g., allergies, renal impairment, metformin, nephrogenic systemic fibrosis (NSF), other contra indications).

- 2.7 The hospital imaging department will have ready access to the latest edition of the *Reference Manual for Magnetic Resonance Safety, Implants and Devices*<sup>7</sup>, or valid registration and login privileges to [www.mrisafety.com](http://www.mrisafety.com). (See [www.mrisafety.com/safety\\_info.asp](http://www.mrisafety.com/safety_info.asp) for a comprehensive list of safety considerations.

### **Assigning a Priority Rating to the MRI or CT Request: Immediate, Urgent, Semi-Urgent and Non-Urgent**

- 2.8 The radiologist will assign a priority rating to the MRI or CT request using the priority rating targets that were developed by the Provincial MRI and CT Expert Panel and accepted by the Ministry of Health and Long-Term Care for use in Ontario. Where hospital policy allows an MRI or CT scan to be performed without the requisition being first reviewed by the radiologist (see 2.5), the examination will be booked using pre-approved priority ratings.

<b>Priority Rating</b>	<b>Maximum Wait Time Targets as Developed by the Provincial MRI and CT Expert Panel and Accepted by the Ontario Ministry of Health and Long-Term Care</b>
1. Immediate	Immediate. Less than 24 hours.
2. Urgent/Inpatient	Within 48 hours.
3. Semi-urgent	Within 2-10 days.
4. Non-urgent	Within 4 weeks (28 days).

### **Assigning an Imaging Protocol**

- 2.9 The radiologist will protocol scans and forward this information to the medical radiation technologist within a timely manner. Where hospital policy allows an MRI or CT scan to be performed without the requisition being first reviewed by the radiologist (see 2.5), the medical radiation technologist will use pre-approved standard MRI and CT scan protocols.

## **3. THE SCAN IS BOOKED AND SCHEDULED**

### **Preamble**

Currently, the Ministry is supporting MRI efficiency coaching teams. The work of these teams will inform the development of best practice guidelines for booking and scheduling MRI and CT scans in the future. As of March 17, 2009 best practices for booking and scheduling scans include:

- Achieving efficiency targets for hours of operation.

<sup>7</sup> Shellock, FG. 2009. *Reference Manual For Magnetic Resonance Safety, Implants, And Devices: 2009 Edition*. Biomedical Research Publishing Company, Los Angeles, CA.

- Achieving efficiency targets for the number of scans per day in adults.
- Achieving efficiency targets for the number of scans per day in paediatric patients and adults with special needs.
- Achieving case accuracy.
- Scheduling scans that need a radiologist to be present.
- Ensuring the appropriate number and mix of staff.

### **Achieving Efficiency Targets for Hours of Operation**

The MRI and CT Expert Panel observed that MRI and CT scanners should operate extended hours to minimize the fixed cost per exam given the enormous capital and operating expenses associated with these sophisticated pieces of equipment.<sup>8</sup> The Panel recommended that the Ministry of Health and Long-Term Care adopt a minimum standard for MRI and CT operations, which was accepted for the province.

- 3.1 Hospital imaging departments will run their MRI and CT operations 16 hours a day, seven days a week (112 hours per week), where human and financial resources permit. Ideally, the operating goal for all MRI scanners will be 24 hours a day, 7 days a week, where human and financial resources permit.
- 3.2 MRIs and CTs will achieve a minimum efficiency of 80% of worked hours, as supported by the Ministry of Health and Long-Term Care. This efficiency target recognises downtime due to regular maintenance.

### **Achieving Efficiency Targets for the Number of Scans per Day in Adults**

The MRI and CT Expert Panel supported the development of common efficiency targets that identify the standard time it should take to scan various body parts. A “scan time” is defined as the time from when the patient enters the scan room to when the patient leaves the room (which includes set up, preparation and scan time). The times suggested by the Expert Panel in April 2005 have been updated. These scan times are valid as of March 2009, and will be continuously reviewed, updated and communicated to the field.

This guideline presents the *average time* to perform a scan in recognition of the fact that the time to perform individual scans will vary depending on the complexity of each case. Generally, teaching hospitals will tend to have more complex cases than community hospitals.

- 3.3 The *average time* to perform adult MRI scans for both in- and out-patients as proposed by the Provincial MRI and CT Expert Panel is as follows:
  - Breast: 1 hour
  - Brain: 0.5 hour;
  - Head and Neck: 0.75 hours;
  - Thorax-Cardiac: 1.5 hours;

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<sup>8</sup> MRI and CT Expert Panel (Anne Keller, Chair). 2005 (April). *MRI and CT Phase I Report*

- Abdomen: 0.75 hours;
- Pelvis: 0.5 hours;
- Extremity: 0.5 hours;
- Multiple Extremities: 1.0 hours;
- Limited Spine: 0.5 hours;
- Multiple Spine: 0.75 hours;
- Gadolinium: 0.25 hours; and
- 3D Image: 0.25 hours.

The *average* time to perform a scan is in recognition of the fact that the time to perform individual scans will vary depending on the complexity of each case.

3.4 Imaging departments will use the following formula to calculate their MRI efficiency:

$$MRI\ Efficiency = [(OHIP\ Exams \times Time\ Allocations + \# \text{ OHIP Inpatient Exams} \times 1 \text{ Hour}) / (\text{Actual OHIP Base Hours} + \text{Actual OHIP Wait Time Incremental Hours})] * 100$$

*Source:*

- Numerator: OHIP exams from Hospital Information System or Radiology Information System; time allocations from Provincial MRI and CT Expert Panel
- Denominator: Actual OHIP hours submitted on Form 5 (base and incremental only)

*Exclusions:* Repeat sequences

3.5 The *average time* to perform an adult CT scan for both in- and out-patients as proposed by the Provincial MRI and CT Expert Panel is 15 minutes regardless of body part.

### **Achieving Efficiency Targets for the Number of Scans per Day in Paediatric Patients and Adults With Special Needs**

The Ontario Children's Health Network MRI/CT Task Group reported that children under the age of six or seven may need to be sedated for a scan whereas infants, toddlers, children and adolescents with a developmental delay or severe medical condition may need a general anaesthetic.<sup>9</sup> The Task Group recommended that adult efficiency targets for MRI and CT be used as a baseline for paediatric patients if general anaesthesia or sedation is not required. Although the Task Group noted that standard scan times need to be developed for paediatric patients who require sedation or general anaesthesia, the group estimated that an additional 20 minutes of table time is needed for sedation and an additional 30 minutes of table time is needed for general anaesthesia. This general guide should also be used for adults with special needs who require sedation or general anaesthesia (e.g., those suffering from claustrophobia, mental illness or disability, severe pain, movement disorders, etc.).

<sup>9</sup> Ontario Children's Health Network MRI/CT Task Force (Cathy Séguin). 2006 (August 22). *OCHN MRI/CT Wait Times Task Force Report*.

- 3.6 The *average time* to perform an MRI or CT for paediatric in- and out- patients and adults with special needs who *require sedation* will be the adult target plus an additional 20 minutes of table time.
- 3.7 The *average time* to perform an MRI or CT for paediatric in- and out-patients and adults with special needs who *require general anaesthesia* will be the adult target plus an additional 30 minutes of table time.

### **Achieving Case Accuracy**

Hospitals need to use their diagnostic imaging resources efficiently and effectively so the most number of patients can benefit. Poor use of these resources can impact negatively on patients and their families, the healthcare team, and the ability of the hospital to provide access to MRI and CT in a timely manner.

Hospitals should use best practices to schedule scans, determine the time and resources needed to perform individual scans, and improve the “arrival to scan time”.

- 3.8 The time the patient goes into the scanning room to the time the patient leaves the scanning room will be equal to the time that was booked for the scan.
- 3.9 The amount of time scheduled for the scan will be as close to the expected time that the scan should take to perform.
- 3.10 The hospital will put practices in place to improve the “arrival to scan” time. These practices can include – but are not limited to – the following: i) simplify and streamline the booking system by reducing examination codes and developing simpler booking templates; ii) reduce interruptions by diverting enquiries to the main reception desk; iii) complete all oral or intravenous preparations outside the scan room as part of the scheduled arrival time; and iv) complete all patient sedation outside of the scan room prior to the examination.
- 3.11 The scan will begin at the scheduled start time.

### **Scheduling Scans That Need a Radiologist to be Present**

There are instances when a radiologist may need to be onsite during the scanning procedure. For example, a complex scan may require the direct supervision of a radiologist during the scanning procedure. The MRI and CT Expert Panel noted that currently, it is common practice to require a radiologist to be on-site for intravenous contrast injections in case there is an allergic reaction. As a result, scans that require contrast cannot be performed unless a radiologist is in the hospital (about 50% of all CT cases). The panel noted that a change in this practice should be considered for two reasons: 1) severe contrast allergic reactions are rare with newer contrast agents; and 2)

patients who have allergic reactions can get emergency care immediately using established hospital emergency response procedures.<sup>10</sup>

A recent pilot project funded by the Ministry of Health and Long-Term Care’s Innovation and Education Fund found that medical radiation technologists and registered nurses – with additional education in contrast media injections – can successfully administer contrast media for adult diagnostic exams after hours without a radiologist present using a medical directive.<sup>11</sup> The Federation of Health Regulatory Colleges of Ontario has a *Guide to Medical Directives and Delegation* which addresses the use of orders – direct orders and medical directives – and delegation across all professions and practice settings.<sup>12</sup> As well, the College of Medical Radiation Technologists of Ontario has developed *Comprehensive Guidelines* which address authorized acts, delegation and agency practices.<sup>13</sup> The College of Nurses of Ontario also has a *Directives Practice Guideline*.<sup>14</sup>

- 3.12 The MRI or CT scan will be scheduled when the radiologist is available only in those instances where the radiologist may need to directly supervise the scan.
- 3.13 Hospitals will develop medical directives or appropriate policies for the administration of contrast media by medical radiation technologists and registered nurses for MRIs and CTs without a radiologist present. Hospitals will ensure that a most responsible clinician has been identified and is available in the facility at all times in the event of allergic reactions to the contrast media and that a “code team” is available for potentially life-threatening reactions. (For a prototype medical directive, see: [http://www.health.gov.on.ca/transformation/wait\\_times/providers/system/innovation/medical\\_directives.pdf](http://www.health.gov.on.ca/transformation/wait_times/providers/system/innovation/medical_directives.pdf).)

### **Ensuring the Appropriate Number and Mix of Staff**

Hospitals that book and schedule MRI and CT scans must have the appropriate number and mix of staff to perform MRI and CT scans, to meet the needs of patients before and after the scan, and to make the most effective and efficient use of hospital resources.

The MRI and CT Expert Panel developed staffing guidelines for medical radiation technologists performing MRI and CT and for radiologists reading these scans. The Panel noted that staffing will vary depending on the type of hospital (teaching, community), the complexity of the scans, the number of scanners and scanner operating

<sup>10</sup> MRI and CT Expert Panel (Anne Keller, Chair). 2006 (December 4). *MRI and CT Phase II Report*.

<sup>11</sup> [http://www.health.gov.on.ca/transformation/wait\\_times/providers/system/si\\_innovation.html](http://www.health.gov.on.ca/transformation/wait_times/providers/system/si_innovation.html). Hamilton Health Sciences, Diagnostic Services Policy. Delegated Controlled Acts and Medical Directives Manual: After Hours – Intravenous Contrast Administration by a Medical Radiation Technologist and/or Registered Nurse (nd).

<sup>12</sup> <http://www.regulatedhealthprofessions.on.ca/PRACTITIONERS/medical.asp>

<sup>13</sup> <http://www.cmrto.org/pdf/comprehensiveGuidelines.pdf>

<sup>14</sup> [http://www.cno.org/docs/prac/41019\\_MedicalDirectives.pdf](http://www.cno.org/docs/prac/41019_MedicalDirectives.pdf)

hours. The Ontario Children’s Health Network MRI/CT Task Group also noted that professionals specialised in paediatric sedation and anaesthesia are required for this patient population.<sup>15</sup>

It is noted that the MRI and CT Expert Panel did not develop guidelines for support staff such as clerks, porters and transcribers. The requirements for these staff will be addressed in the future. Although the effective use of these staff will increase the efficiency of the medical radiation technologists, the Association of Medical Radiation Technologists supports a minimum of two MRI technologists per shift at all times to ensure efficiency, safety and effective quality care.<sup>16</sup>

3.14 The staffing required to support MRI and CT services will vary depending on the type of hospital (e.g., teaching, community), the complexity of the scans, the number of scanners and scanner operating hours. Staff who need to be considered include medical radiation technologists, radiologists and support staff (e.g., clerks, porters, transcribers).

### ***Medical Radiation Technologist Staffing***

3.15 Medical radiation technologist staffing *guidelines* for MRI in teaching and community hospitals – as recommended by the Provincial MRI and CT Expert Panel – will be as follows:

#### **Medical Radiation Technologist Staffing for MRI by Number of MRIs, Operating Hours and Type of Hospital (Adult Patients) as Recommended by the Provincial MRI and CT Expert Panel\***

Number of MRIs	Operating Hours	Number of Full-Time Equivalents (FTEs)	
		Community Hospital	Tertiary Hospital
One Scanner	16 hours a day, 7 days a week (16/7)	7.2 FTEs	7.7 FTEs
Two Scanners	16 hours a day, 7 days a week (16/7)	8.7 FTEs	10.6 FTEs
One Scanner	24 hours a day, 7 days a week (24/7)	10.6 FTEs	10.6 FTEs
Two Scanners	24 hours a day, 7 days a week (24/7)	13.1 FTEs	15.4 FTEs

\*Source: MRI and CT Expert Panel (Anne Keller, Chair). 2006 (December 4). *MRI and CT Phase II Report*. Assumptions: 1) Technologists are trained in intravenous insertion and contrast administration. 2) Staff include image post-processing in their work schedule (e.g. no dedicated 3D computer lab). 3) Gadolinium is used in less than 20% of cases in community hospitals, and in more than 20% of cases in tertiary hospitals. 4) Vacation is four weeks. 5) An eight-hour shift will require approximately two full time equivalents (FTEs). 6) Wherever possible, two technologists are recommended for the evening and night shifts for safety and improved efficiency. 7) Models do not include porter, transcription, clerical, Registered Nurse or Registered Practical Nurse support.

<sup>15</sup> Ontario Children’s Health Network MRI/CT Task Force (Cathy Séguin). 2006 (August 22). *OCHN MRI/CT Wait Times Task Force Report*.

<sup>16</sup> Association of Medical Radiation Technologists Policies and Procedures: Staffing Standards MRI Facilities Document No: POSN 02-01-26 (effective date 18 Oct 03).

- 3.16 Medical radiation technologist staffing *guidelines* for CT in all hospitals – as recommended by the Provincial MRI and CT Expert Panel – will be as follows:

**Medical Radiation Technologist Staffing for CT by Number of CTs and Operating Hours (Adult Patients) as Recommended by the Provincial MRI and CT Expert Panel\***

Number of CTs	Operating Hours	Number of Full-Time Equivalents (FTEs)
One Scanner	16 hours a day, 7 days a week (16/7)	5.7 FTEs
Two Scanners	16 hours a day, 7 days a week (16/7)	8.2 FTEs

\*Source: MRI and CT Expert Panel (Anne Keller, Chair). 2006 (December 4). *MRI and CT Phase II Report*. Assumptions: 1) Technologists are trained in intravenous insertion and contrast administration. 2) Staff include image post-processing in their work schedule (e.g. no dedicated 3D computer lab). 3) Technologists are trained to scan non-contrast heads and renal colic after hours. 4) Vacation is four weeks. 5) An eight-hour shift will require approximately two full time equivalents (FTEs). 6) Wherever possible, two technologists are recommended for the evening and night shifts for safety and improved efficiency. 7) Models do not include porter, transcription, clerical, Registered Nurse or Registered Practical Nurse support.

***Radiologist Staffing***

The MRI and CT Expert Panel suggested that – on average – one radiologist can report a *minimum* of 25 complex CT cases per day or a *minimum* of 15 complex MRI cases per day. Based on this assumption, the Panel estimated the number of radiologists who are needed to support MRI and CT scanning, by the number of scanners and hours of operation.

- 3.17 Radiologist staffing *guidelines* for MRI and CT – as recommended by the Provincial MRI and CT Expert Panel – will be as follows:

**Radiologist Staffing for MRI and CT by Number of Scanners and Operating Hours (Adult Patients) as Recommended by the Provincial MRI and CT Expert Panel\***

<b>MRI (Assuming 1.6 exams per hour)</b>			
Number of MRIs per Site	Hours of Operation	Number of Exams	Number of Radiologists
One MRI	16/7	8,960	1.7
One MRI	24/7	13,440	2.6
Two MRIs	16/7	17,920	3.4
Two MRIs	24/7	26,880	5.1
<b>CT (assuming 3 exams per hour)</b>			
Number of CTs per Site	Hours of Operation	Number of Exams	Number of Radiologists
One CT	16/7	16,800	1.9
Two CTs	16/7	33,600	3.8

Source: MRI and CT Expert Panel (Anne Keller, Chair). 2006 (December 4). *MRI and CT Phase II Report*. Assumptions: Staffing does not take into account time for vacation, research and teaching.

## 4. THE PATIENT IS PREPARED FOR THE SCAN

### Preamble

To make the most effective use of MRI and CT resources, hospital booking departments need to have simple procedures to minimise delayed and cancelled MRIs and CTs. Generally, fewer in-patient scans are delayed or cancelled since hospitals follow appropriate procedures and actively prepare the patient for the scan. With out-patient scans, it is left up to individual patients to prepare for the scan and keep their appointment. The extent to which MRIs or CTs are delayed or cancelled in Ontario hospitals is unknown. However, a British review of surgeries cancelled on the day of the operation found that 21% were cancelled because the patient did not show up and 12% were cancelled because the patient was unfit for surgery.<sup>17</sup>

In addition to minimising delayed and cancelled MRIs and CTs, patients must be prepared for the scan. Performing an MRI or CT must be patient- and family-centred. Diagnostic imaging departments need to ensure that patients have the information they need, their questions are answered, and they know what to expect during and after the scan.

Best practice guidelines to prepare the patient for the scan include:

- Minimising delayed and cancelled scans.
- Informing and preparing the patient.

### Minimising Delayed and Cancelled Scans

- 4.1 Hospitals will put procedures and resources in place to minimise delayed and cancelled MRIs and CTs. Procedures could include calling patients the day before the scan, sending a follow-up reminder, and regularly analysing the number of and reasons for “no shows” to identify solutions to the issue.

### Informing and Preparing the Patient

- 4.2 The medical radiation technologist (MRT) will provide clear and understandable information to the patient or the patient’s substitute decision maker prior to, during, and after the scan using an interpreter, if necessary (e.g., how the scan is performed, the purpose, benefits, risks, etc.). The MRT will answer any questions within the scope of his or her responsibility, and obtain answers to questions that

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<sup>17</sup> *Tackling Cancelled Operations: Interim Guidance from the NHS Modernisation Agency Theatre Project*, December 2001.

- go beyond their scope.<sup>18</sup> (See Appendix C, *Information for Patients on MRI and CT.*)
- 4.3 The physician who gives the order for an MRI or CT scan is responsible for assessing the capacity of the patient and obtaining informed consent for the scan, in most circumstances. The health practitioner performing the treatment under the order of a physician – usually the medical radiation technologist – should be able to rely on the informed consent having been obtained if it is reasonable to do so.<sup>19</sup>
- 4.4 Although the responsibility to obtain the patient's informed consent rests in most circumstances with the physician (see 1.4), medical radiation technologists (MRTs) have certain obligations which include:
- Ensuring that the physician has obtained the patient's consent by determining whether the consent is documented in the patient record or there is other reasonable evidence that consent was obtained.
  - Before beginning the procedure or treatment, the MRT should fully explain to the patient what the MRT is going to do and why.
  - If the patient gives any sign of not knowing or understanding the procedure, the MRT should not perform the procedure even if the patient's record indicates that consent has been given. The patient should be referred back to the physician to ensure informed consent is obtained.
  - Assuming the patient is mentally capable, he or she can withdraw consent to a procedure at any time. If there are any indications consent has been withdrawn, the MRT should not perform the procedure until the patient's consent is obtained.
  - If the MRT is in doubt about whether the patient is capable of giving consent, or has given an informed consent, the MRT should refer the patient back to the responsible physician.
  - The MRT should make certain that the hospital or facility has procedures or protocols in place which address the following: i) Who is the appropriate health care provider to inform the patient about the proposed treatment and to obtain the consent; ii) How will the patient's consent be documented so that other members of the health care team know the consent was obtained; iii) What steps should be taken if a health care professional has reason to believe that the patient's consent was not informed, that the patient has changed his or her mind, or that he or she is not, or was not, capable of giving consent to the proposed treatment.<sup>20</sup>

<sup>18</sup> See College of Medical Radiation Technologists of Ontario: Standards of Practice. *Essential Competencies and the Comprehensive Guidelines for acting in accordance with the Regulated Health Professions Act Scope of Practice/Controlled Acts Model, as amended by the Addendum to the Comprehensive Guidelines.* (<http://www.cmrto.org/practice/standards-practice.asp>).

<sup>19</sup> See College of Medical Radiation Technologists of Ontario: Standards of Practice. *Essential Competencies and the Comprehensive Guidelines for acting in accordance with the Regulated Health Professions Act Scope of Practice/Controlled Acts Model, as amended by the Addendum to the Comprehensive Guidelines* (<http://www.cmrto.org/practice/consent-act.asp>).

<sup>20</sup> See College of Medical Radiation Technologists of Ontario: Standards of Practice. *Essential Competencies and the Comprehensive Guidelines for acting in accordance with the Regulated Health*

## 5. THE MRI OR CT SCAN IS PERFORMED

### Preamble

Best practice guidelines for when the MRI or CT scan is performed include:

- Optimising patient safety.
- Supporting safe sedation in children and selected adult populations.

### Optimising Patient Safety

The MRI and CT Expert Panel emphasized that Ontario's MRI and CT services need to be of the highest quality and provided in the most safe and effective manner. Although Ontario's MRI and CT scanners must pass safety guidelines, the panel noted that they do not need to be accredited for meeting quality standards.<sup>21</sup>

The Canadian Association of Radiologists has developed a Radiation Awareness Action Plan for Canada that is supported by a three-part strategy that includes better governance of radiology, more research and promotion of best practices ([www.car.ca](http://www.car.ca)). With regard to the latter, CAR advocates educating medical practitioners, radiologists and technologists on how to reduce radiation risk to patients through such best practices as:

- Knowing accurately what dose is being administered and how it compares to reference standards for specific exams.
- Understanding the role of CT in diagnostic algorithms and the minimum radiation dose needed to support the diagnostic findings.
- Knowing how to use scanner tools to both assess and reduce CT radiation dose.
- Working with the manufacturers to encourage improved radiation dosage monitoring and output of the CT scanners and other radiology equipment.
- Encouraging physician to include radiologist consultations in discussing options to reduce unnecessary exposure to their patients.

The American College of Radiology (ACR) is recognised for its diagnostic and radiation oncology accreditation programs. Their educational programs evaluate the qualifications of personnel, equipment performance, quality control measures, and the quality of clinical images. In particular, the CT and MRI Accreditation Programs involve the:

- Acquisition of clinical and phantom images;
- Corresponding data for each magnet (including 3.0 Tesla units) and/or CT dose measurements;
- Submission of scanning protocols;
- Evidence of professional registration (i.e., appropriate training);
- Continuing medical education (i.e., appropriate upgrading); and

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*Professions Act Scope of Practice/Controlled Acts Model, as amended by the Addendum to the Comprehensive Guidelines* (<http://www.cmrtto.org/practice/consent-act.asp>).

<sup>21</sup> MRI and CT Expert Panel (Anne Keller, Chair). 2006 (December 4). *MRI and CT Phase II Report*.

- Continuous quality control testing and quality assurance.

The MRI and CT panel recommended that all current and future MRI and CT sites in Ontario obtain ACR accreditation. The panel further recommended that the Canadian Association of Radiologists establish similar standards for Canadian CT and MRI facilities in the near future.<sup>22</sup> CAR has not yet established these standards. MRI and CT accreditation would be consistent with current accreditation standards for mammography.

- 5.1 All MRI and CT sites in Ontario should review the American College of Radiology's CT and MRI Accreditation Program, and work towards meeting these accreditation requirements.

### **Supporting Safe Sedation in Children and Adults With Special Needs**

The MRI and CT Expert Panel noted that policies are needed to support safely sedating children and selected adults when they receive an MRI or CT scan (i.e., safe administration of oral or intravenous drugs or general anaesthesia).<sup>23</sup> Currently, paediatric hospitals have policies in place to sedate children safely, however, these policies and practices do not extend to paediatric patients who are in adult hospitals. Similarly, these policies and practices do not extend to adults with special needs who may require sedation or anaesthesia before an MRI or CT scan (e.g., those suffering from claustrophobia, mental illness or disability, severe pain, movement disorders, etc.).

- 5.2 All MRI and CT sites in Ontario will develop policies and procedures for safely performing MRIs or CTs on children and adults with special needs who may need sedation or anaesthesia.

## **6. THE RADIOLOGIST INTERPRETS THE SCAN AND COMPLETES THE CONSULTATIVE REPORT**

### **Preamble**

Waiting for an MRI or CT scan does not end when the scan has been completed. Rather, the radiologist must interpret the scan and complete a report in a timely manner so that the patient can receive his or her diagnosis and begin any necessary treatment. (In teaching hospitals, a radiology resident or fellow may be responsible for reading the scan and completing the verified report.) Best practice guidelines include:

- Maximising the efficient and effective use of the radiologist's expertise to interpret scans.
- Interpreting the scan and completing the consultative report in a timely manner.

<sup>22</sup> MRI and CT Expert Panel (Anne Keller, Chair). 2006 (December 4). *MRI and CT Phase II Report*.

<sup>23</sup> MRI and CT Expert Panel (Anne Keller, Chair). 2006 (December 4). *MRI and CT Phase II Report*.

## **Maximising the Efficient and Effective Use of the Radiologist’s Expertise to Interpret Scans**

- 6.1 The hospital will provide technologies to maximise the efficient and effective use of the radiologist’s expertise to read scans. This may include but is not limited to PACS (Picture Archive and Communication System), voice recognition technology, appropriate transcription support, etc.

## **Interpreting the Scan and Completing the Consultative Report in a Timely Manner**

- 6.2 The radiologist (or radiology resident/fellow) will interpret scans with an “immediate” priority rating (priority 1) and those with unusual or unexpected findings that require immediate case management decisions, and provide a verbal report to the referring physician immediately. Within 24 hours of the verbal report, the radiologist (or radiology resident/fellow) will dictate his or her report, support staff will transcribe and return the draft emergency report to the radiologist (or radiology resident/fellow), and the radiologist (or radiology resident/fellow) will verify the final report.
- 6.3 The radiologist (or radiology resident/fellow) will interpret and dictate MRI and CT scans with an “urgent” or “semi-urgent” priority rating (priority 2 and 3) within 24 hours. In cases with unusual or unexpected findings that require immediate case management decisions, the radiologist will provide a verbal report to the referring physician immediately. Within 24 hours of the verbal report, the radiologist (or radiology resident/fellow) will dictate his or her report, support staff will transcribe and return the draft report to the radiologist (or radiology resident/fellow), and the radiologist (or radiology resident/fellow) will verify the final report.
- 6.4 The radiologist (or radiology resident/fellow) will interpret and dictate MRI and CT scans with a “non-urgent” priority rating (priority 4) within 48 hours. Support staff will transcribe and return the draft report to the radiologist (or radiology resident/fellow) who will verify the final report within 48 hours.

## **7. THE VERIFIED REPORT IS PROVIDED TO THE REFERRING PHYSICIAN**

### **Providing the Verified Report to the Referring Physician**

- 7.1 The hospital will ensure that the written report is forwarded to the referring physician immediately after the radiologist (or radiology resident/fellow) has verified the report.

## **8. ACCOUNTABILITY FOR AN EFFICIENT AND EFFECTIVE MRI AND CT PROGRAM AND ONGOING IMPROVEMENT**

### **Preamble**

To ensure that diagnostic imaging resources are used as effectively and efficiently as possible, there must be clear accountabilities for planning and managing a hospital's MRI and CT services. Best practice guidelines in this area include:

- Developing clear program accountabilities; and
- Collecting data to monitor and improve performance.

### **Developing Clear Program Accountabilities**

- 8.1 Hospitals will identify an MRI/CT lead who is responsible and accountable to hospital senior management for managing and improving performance and collecting key performance indicators of efficiency and effectiveness.
- 8.2 The MRI/CT lead will
- Develop an objective process to monitor performance, allocate resources and set MRI and CT management goals;
  - Initiate and oversee action-oriented continuous quality improvement strategies based on outcomes;
  - Determine and monitor safe practices;
  - Measure the effective and efficient use of resources and reduce variation;
  - Monitor performance by identifying blockages and issues at the individual provider, service and hospital levels;
  - Approve communication materials for physicians and patients; and
  - Determine safe practices.

### **Collecting Data to Monitor and Improve Performance**

- 8.3 All hospitals will collect and routinely analyse information that focuses on monitoring and improving their MRI and CT performance on an ongoing basis.

Hospitals should consider – but not be limited to – collecting the following information:

- Supply and demand for MRI and CT: number of MRI and CT requests received each week, number of scans completed each week.
- Obstacles to effective throughput: number of requisitions that are incomplete, number of “no-shows” and the reasons why (e.g., patient transport), number of re-bookings, time to protocol, equipment down-time, radiologist access.
- Booking time: time between the exam is ordered, booked and received.
- Scan wait time: Date the requisition was received to the scan date.
- Priority category: Number of patients in each priority level, each month.
- Procedure duration: length of exam (the time the patient is on the table).

- Procedure turnaround time (the time the patient is in the room).
- Patients scanned per operating hour.
- Report time: time between the procedure is completed, the report is completed and verified, and the report is faxed or mailed to the referring physician.
- Report verification time: the time between the report is completed and signed off.
- The number of outstanding exams that are not reported to the referring physician: number of exams each week.

**SUMMARY: BEST PRACTICE GUIDELINES CHECKLIST**

<b>Guidelines</b>		<b>Level of Planning and Implementation</b>			
		<b>1 None</b>	<b>2 Being Planned</b>	<b>3 Beginning to Implement</b>	<b>4 Full</b>
<b>1</b>	<b>The Decision is Made to Request an MRI or CT Scan</b>				
<b><i>Being Knowledgeable About the Indications for MRI and CT and Making the Appropriate Decision</i></b>					
1.1	The <i>referring</i> physician will be knowledgeable about the indications for an MRI or CT scan and will order the scan only when appropriate. The physician's knowledge should include training on the appropriate use of MRI and CT and the use of best practice guidelines (e.g., American College of Radiology, Canadian Association of Radiologists). (See Appendix B, <i>Physician Education and Knowledge When Ordering an MRI or CT.</i> )				
1.2	The <i>referring</i> physician will be fully aware of the patient's medical history and any contraindications that might impact on the patient safely receiving an MRI or CT. Where necessary, the referring physician will perform the appropriate tests to inform his or her decision (e.g., blood work). See the Canadian Association of Radiologists for standards for CT and MRI scans.				
<b><i>Informing the Patient</i></b>					
1.3	The <i>referring</i> physician will describe to his or her patient (or substitute decision maker) what an MRI or CT scan is and how it is performed, the benefits and risks of the procedure, and how the patient may benefit from the examination. The <i>referring</i> physician will ensure that the patient (or substitute decision maker) has sufficient information to proceed knowledgeably with the scan. (See Appendix C, <i>Information for Patients on MRI and CT.</i> )				
1.4	The physician who gives the order for an MRI or CT scan is responsible for assessing the capacity of the patient and obtaining informed consent for the scan, in most circumstances (see 4.3).				
<b><i>Completing the Request Form</i></b>					
1.5	The <i>referring</i> physician will complete and sign the requisition and screening forms required by the receiving hospital for an MRI or CT scan, appropriately assess the patient's urgency for a scan, and provide all necessary information to support the request (e.g., blood work results, contraindications, previous relevant examinations).				
1.6	The <i>referring</i> physician will refrain from sending out requests for an MRI or CT scan to multiple hospitals simultaneously.				
<b>2</b>	<b>The Imaging Department Receives and Evaluates the Scan Request</b>				
<b><i>Ensuring the Request Form is Properly Completed</i></b>					
2.1	The booking personnel (e.g., booking clerk, scheduler, etc.) will review the request for an MRI or CT to ensure that the form is completed properly and legibly signed by the referring physician, contraindications are identified and all supporting information is provided. This may include basic client identifiers (e.g., name, health number, date of birth, gender), name of the most responsible physician, names of other medical professional(s), all relevant clinical information, type of procedure and special instructions.				
2.2	If a request for an MRI or CT is made by telephone, the booking personnel (e.g., booking clerk, scheduler, etc.) will collect and record the information and proceed to book the case. The scan will not be performed until a written requisition form signed by the referring physician is received (fax, mail, electronic-mail).				

Guidelines		Level of Planning and Implementation													
		1 None	2 Being Planned	3 Beginning to Implement	4 Full										
2.3	If the request for an MRI or CT scan is incomplete, the booking personnel (e.g., booking clerk, scheduler, etc.) will contact the referring physician for the additional information or, if appropriate, interview the patient to obtain the necessary information.														
<b>Assessing the Appropriateness of the Scan Request</b>															
2.4	The radiologist will review the scan request to assess whether an MRI or CT scan is appropriate. The radiologist will assess whether an MRI or CT scan is justified given the patient’s pertinent clinical information, and whether the scan can be performed safely. If, in the radiologist’s professional opinion, an MRI or CT scan is inappropriate, he or she will contact the referring physician to discuss the issue and alternative courses of action.														
2.5	Hospitals will develop clear operating policies outlining when an MRI or CT scan can be performed without the requisition being first reviewed by the radiologist (e.g., cancer follow-up).														
<b>Assessing the Safety of the Scan Request</b>															
2.6	All patients referred for an MRI or CT scan will be screened to ensure that the scan can be done safely and with minimal risk to the patient. This includes, but is not limited to, the following considerations: <ul style="list-style-type: none"> <li>• The patient is pregnant and there is potential risk to the fetus.</li> <li>• The patient has an implanted device, and the radiologist or technologist must confirm that the device can safely go through the magnetic field of the MRI scanner.</li> <li>• The patient has an external electronic device that is contraindicated for MRI (e.g., Holter monitor).</li> <li>• The possibility of metallic foreign bodies needs to be excluded by ordering and reviewing X-rays (e.g., orbit).</li> <li>• Patients who need IV contrast need to be screened to ensure the contrast can be injected safely and that potential risks are minimised (e.g., allergies, renal impairment, metformin, nephrogenic systemic fibrosis (NSF), other contra indications).</li> </ul>														
2.7	The hospital imaging department will have ready access to the latest edition of the <i>Reference Manual for Magnetic Resonance Safety, Implants and Devices</i> <sup>24</sup> , or valid registration and login privileges to <a href="http://www.mrisafety.com">www.mrisafety.com</a> . (See <a href="http://www.mrisafety.com/safety_info.asp">www.mrisafety.com/safety_info.asp</a> for a comprehensive list of safety considerations.)														
<b>Assigning a Priority Rating to the MRI or CT Request: Immediate, Urgent, Semi-Urgent and Non-Urgent</b>															
2.8	The radiologist will assign a priority rating to the MRI or CT request using the priority rating targets that were developed by the Provincial MRI and CT Expert Panel and accepted by the Ministry of Health and Long-Term Care for use in Ontario. Where hospital policy allows an MRI or CT scan to be performed without the requisition being first reviewed by the radiologist (see 2.5), the examination will be booked using pre-approved priority ratings. <table border="1" data-bbox="283 1096 1407 1274" style="margin-left: 20px;"> <thead> <tr> <th>Priority Rating</th> <th>Maximum Wait Time Targets as Developed by the Provincial MRI and CT Expert Panel and Accepted by the Ontario Ministry of Health and Long-Term Care</th> </tr> </thead> <tbody> <tr> <td>1. Immediate</td> <td>Immediate. Less than 24 hours.</td> </tr> <tr> <td>2. Urgent/Inpatient</td> <td>Within 48 hours.</td> </tr> <tr> <td>3. Semi-urgent</td> <td>Within 2-10 days.</td> </tr> <tr> <td>4. Non-urgent</td> <td>Within 4 weeks (28 days).</td> </tr> </tbody> </table>	Priority Rating	Maximum Wait Time Targets as Developed by the Provincial MRI and CT Expert Panel and Accepted by the Ontario Ministry of Health and Long-Term Care	1. Immediate	Immediate. Less than 24 hours.	2. Urgent/Inpatient	Within 48 hours.	3. Semi-urgent	Within 2-10 days.	4. Non-urgent	Within 4 weeks (28 days).				
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<sup>24</sup> Shellock, FG. 2009. *Reference Manual For Magnetic Resonance Safety, Implants, And Devices: 2009 Edition*. Biomedical Research Publishing Company, Los Angeles, CA.

Guidelines		Level of Planning and Implementation			
		1 None	2 Being Planned	3 Beginning to Implement	4 Full
<b>Assigning an Imaging Protocol</b>					
2.9	The radiologist will protocol scans and forward this information to the medical radiation technologist within a timely manner. Where hospital policy allows an MRI or CT scan to be performed without the requisition being first reviewed by the radiologist (see 2.5), the medical radiation technologist will use pre-approved standard MRI and CT scan protocols.				
<b>3</b>	<b>The Scan is Booked and Scheduled</b>				
<b>Achieving Efficiency Targets for Hours of Operation</b>					
3.1	Hospital imaging departments will run their MRI and CT operations 16 hours a day, seven days a week (112 hours per week), where human and financial resources permit. Ideally, the operating goal for all MRI scanners will be 24 hours a day, 7 days a week, where human and financial resources permit.				
3.2	MRIs and CTs will achieve a minimum efficiency of 80% of worked hours, as supported by the Ministry of Health and Long-Term Care. This efficiency target recognises downtime due to regular maintenance.				
<b>Achieving Efficiency Targets for the Number of Scans per Day in Adults</b>					
3.3	The <b>average time</b> to perform adult MRI scans for both in- and out-patients as proposed by the Provincial MRI and CT Expert Panel is as follows: Breast: 1 hour. Brain: 0.5 hour. Head and Neck: 0.75 hours. Thorax-Cardiac: 1.5 hours. Abdomen: 0.75 hours. Pelvis: 0.5 hours. Extremity: 0.5 hours. Multiple Extremities: 1.0 hours. Limited Spine: 0.5 hours. Multiple Spine: 0.75 hours. Gadolinium: 0.25 hours. 3D Image: 0.25 hours. The <b>average time</b> to perform a scan is in recognition of the fact that the time to perform individual scans will vary depending on the complexity of each case.				
3.4	Imaging departments will use the following formula to calculate their MRI efficiency: $MRI\ Efficiency = [(OHIP\ Exams \times Time\ Allocations + \# \text{ OHIP Inpatient Exams} \times 1 \text{ Hour}) / (\text{Actual OHIP Base Hours} + \text{Actual OHIP Wait Time Incremental Hours})] * 100$ <i>Source:</i> <ul style="list-style-type: none"> <li>• Numerator: OHIP exams from Hospital Information System or Radiology Information System; time allocations from Provincial MRI and CT Expert Panel</li> <li>• Denominator: Actual OHIP hours submitted on Form 5 (base and incremental only)</li> </ul> <i>Exclusions:</i> Repeat sequences				
3.5	The <b>average time</b> to perform an adult CT scan for both in- and out-patients as proposed by the Provincial MRI and CT Expert Panel is 15 minutes regardless of body part.				
<b>Achieving Efficiency Targets for the Number of Scans per Day in Paediatric Patients and Adults with Special Needs</b>					
3.6	The <b>average time</b> to perform an MRI or CT for paediatric in- and out- patients and adults with special needs who <i>require sedation</i> will be the adult target plus an additional 20 minutes of table time.				
3.7	The <b>average time</b> to perform an MRI or CT for paediatric in- and out-patients and adults with special needs who <i>require general anaesthesia</i> will be the adult target plus an additional 30 minutes of table time.				
<b>Achieving Case Accuracy</b>					
3.8	The time the patient goes into the scanning room to the time the patient leaves the scanning room will be equal to the time that was booked for the scan.				

Guidelines		Level of Planning and Implementation																									
		1 None	2 Being Planned	3 Beginning to Implement	4 Full																						
3.9	The amount of time scheduled for the scan will be as close to the expected time that the scan should take to perform.																										
3.10	The hospital will put practices in place to improve the “arrival to scan” time. These practices can include – but are not limited to – the following: i) simplify and streamline the booking system by reducing examination codes and developing simpler booking templates; ii) reduce interruptions by diverting enquiries to the main reception desk; iii) complete all oral or intravenous preparations outside the scan room as part of the scheduled arrival time; and iv) complete all patient sedation outside of the scan room prior to the examination.																										
3.11	The scan will begin at the scheduled start time.																										
<b><i>Scheduling Tests That Need a Radiologist to be Present</i></b>																											
3.12	The MRI or CT scan will be scheduled when the radiologist is available only in those instances where the radiologist may need to directly supervise the scan.																										
3.13	Hospitals will develop medical directives or appropriate policies for the administration of contrast media by medical radiation technologists and registered nurses for MRIs and CTs without a radiologist present. Hospitals will ensure that a most responsible clinician has been identified and is available in the facility at all times in the event of allergic reactions to the contrast media and that a “code team” is available for potentially life-threatening reactions. (For a prototype medical directive, see: <a href="http://www.health.gov.on.ca/transformation/wait_times/providers/system/innovation/medical_directives.pdf">http://www.health.gov.on.ca/transformation/wait_times/providers/system/innovation/medical_directives.pdf</a> ).																										
<b><i>Ensuring the Appropriate Number and Mix of Staff</i></b>																											
3.14	The staffing required to support MRI and CT services will vary depending on the type of hospital (e.g., teaching, community), the complexity of the scans, the number of scanners and scanner operating hours. Staff who need to be considered include medical radiation technologists, radiologists and support staff (e.g., clerks, porters, transcribers).																										
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<b>4</b>	<b>The Patient is Prepared for the Scan</b>				
<b><i>Minimising Delayed and Cancelled Scans</i></b>					
4.1	Hospitals will put procedures and resources in place to minimise delayed and cancelled MRIs and CTs. Procedures could include calling patients the day before the scan, sending a follow-up reminder, and regularly analysing the number of and reasons for “no shows” to identify solutions to the issue.				
<b><i>Informing and Preparing the Patient</i></b>					
4.2	The medical radiation technologist (MRT) will provide clear and understandable information to the patient or the patient’s substitute decision maker prior to, during, and after the scan using an interpreter, if necessary (e.g., how the scan is performed, the purpose, benefits, risks, etc.). The MRT will answer any questions within the scope of his or her responsibility, and obtain answers to questions that go beyond their scope. (See Appendix C, <i>Information for Patients on MRI and CT.</i> )				
4.3	The physician who gives the order for an MRI or CT scan is responsible for assessing the capacity of the patient and obtaining informed consent for the scan, in most circumstances. The health practitioner performing the treatment under the order of a physician – usually the medical radiation technologist – should be able to rely on the informed consent having been obtained if it is reasonable to do so (see 1.4).				
4.4	<p>Although the responsibility to obtain the patient's informed consent rests in most circumstances with the physician, medical radiation technologists (MRTs) have certain obligations which include:</p> <ul style="list-style-type: none"> <li>• Ensuring that the physician has obtained the patient's consent by determining whether the consent is documented in the patient record or there is other reasonable evidence that consent was obtained.</li> <li>• Before beginning the procedure or treatment, the MRT should fully explain to the patient what the MRT is going to do and why.</li> <li>• If the patient gives any sign of not knowing or understanding the procedure, the MRT should not perform the procedure even if the patient’s record indicates that consent has been given. The patient should be referred back to the physician to ensure informed consent is obtained.</li> <li>• Assuming the patient is mentally capable, he or she can withdraw consent to a procedure at any time. If there are any indications consent has been withdrawn, the MRT should not perform the procedure until the patient's consent is obtained.</li> <li>• If the MRT is in doubt about whether the patient is capable of giving consent, or has given an informed consent, the MRT should refer the patient back to the responsible physician.</li> <li>• The MRT should make certain that the hospital or facility has procedures or protocols in place which address the following: <ul style="list-style-type: none"> <li>i) Who is the appropriate health care provider to inform the patient about the proposed treatment and to obtain the consent;</li> <li>ii) How will the patient's consent be documented so that other members of the health care team know the consent was obtained;</li> <li>iii) What steps should be taken if a health care professional has reason to believe that the patient's consent was not informed, that the patient has changed his or her mind, or that he or she is not, or was not, capable of giving consent to the proposed treatment.</li> </ul> </li> </ul>				

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<b>5</b>	<b>The MRI or CT Scan is Performed</b>				
<i>Optimising Patient Safety</i>					
5.1	All MRI and CT sites in Ontario should review the American College of Radiology's CT and MRI Accreditation Program, and work towards meeting these accreditation requirements.				
<i>Supporting Safe Sedation in Children and Adults With Special Needs</i>					
5.2	All MRI and CT sites in Ontario will develop policies and procedures for safely performing MRIs or CTs on children and adults with special needs who may need sedation or anaesthesia.				
<b>6</b>	<b>The Radiologist Interprets the Scan and Completes the Consultative Report</b>				
<i>Maximising the Efficient and Effective Use of the Radiologist's Expertise to Interpret Scans</i>					
6.1	The hospital will provide technologies to maximise the efficient and effective use of the radiologist's expertise to read scans. This may include but is not limited to PACS (Picture Archive and Communication System), voice recognition technology, appropriate transcription support, etc.				
<i>Interpreting the Scan and Completing the Consultative Report in a Timely Manner</i>					
6.2	The radiologist (or radiology resident/fellow) will interpret scans with an "immediate" priority rating (priority 1) and those with unusual or unexpected findings that require immediate case management decisions, and provide a verbal report to the referring physician immediately. Within 24 hours of the verbal report, the radiologist (or radiology resident/fellow) will dictate his or her report, support staff will transcribe and return the draft emergency report to the radiologist (or radiology resident/fellow), and the radiologist (or radiology resident/fellow) will verify the final report.				
6.3	The radiologist (or radiology resident/fellow) will interpret and dictate MRI and CT scans with an "urgent" or "semi-urgent" priority rating (priority 2 and 3) within 24 hours. In cases with unusual or unexpected findings that require immediate case management decisions, the radiologist will provide a verbal report to the referring physician immediately. Within 24 hours of the verbal report, the radiologist (or radiology resident/fellow) will dictate his or her report, support staff will transcribe and return the draft report to the radiologist (or radiology resident/fellow), and the radiologist (or radiology resident/fellow) will verify the final report.				
6.4	The radiologist (or radiology resident/fellow) will interpret and dictate MRI and CT scans with a "non-urgent" priority rating (priority 4) within 48 hours. Support staff will transcribe and return the draft report to the radiologist (or radiology resident/fellow) who will verify the final report within 48 hours.				
<b>7</b>	<b>The Verified Report is Provided to the Referring Physician</b>				
<i>Providing the Verified Report to the Referring Physician</i>					
7.1	The hospital will ensure that the written report is forwarded to the referring physician immediately after the radiologist (or radiology resident/fellow) has verified the report.				

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<b>8</b>	<b>Program Accountability for an Efficient and Effective MRI and CT Program and Ongoing Improvement</b>				
<i>Developing Clear Program Accountabilities</i>					
8.1	Hospitals will identify an MRI/CT lead who is responsible and accountable to hospital senior management for managing and improving performance and collecting key performance indicators of efficiency and effectiveness.				
8.2	The MRI/CT lead will <ul style="list-style-type: none"> <li>• Develop an objective process to monitor performance, allocate resources and set MRI and CT management goals;</li> <li>• Initiate and oversee action-oriented continuous quality improvement strategies based on outcomes;</li> <li>• Determine and monitor safe practices;</li> <li>• Measure the effective and efficient use of resources and reduce variation;</li> <li>• Monitor performance by identifying blockages and issues at the individual provider, service and hospital levels;</li> <li>• Approve communication materials for physicians and patients; and</li> <li>• Determine safe practices.</li> </ul>				
8.3	All hospitals will collect and routinely analyse information that focuses on monitoring and improving their MRI and CT performance on an ongoing basis.				

## **FOR ADDITIONAL INFORMATION**

American College of Radiology: [www.acr.org](http://www.acr.org).

Canadian Association of Radiologists: [www.car.ca](http://www.car.ca).

College of Medical Radiation Technologists of Ontario, *Comprehensive Guidelines* (authorized acts, delegation and agency practices):  
<http://www.cmrto.org/pdf/comprehensiveGuidelines.pdf> .

College of Medical Radiation Technologists of Ontario, *Essential Competencies and the Comprehensive Guidelines for acting in accordance with the Regulated Health Professions Act Scope of Practice/Controlled Acts Model, as amended by the Addendum to the Comprehensive Guidelines*: (<http://www.cmrto.org/practice/standards-practice.asp>).

College of Nurses of Ontario, *Directives Practice Guideline*:  
[http://www.cno.org/docs/prac/41019\\_MedicalDirectives.pdf](http://www.cno.org/docs/prac/41019_MedicalDirectives.pdf).

Federation of Health Regulatory Colleges of Ontario, *Guide to Medical Directives and Delegation*: <http://www.regulatedhealthprofessions.on.ca/PRACTITIONERS/medical.asp>.

MRI and CT Expert Panel (Anne Keller, Chair). 2005 (April). *Phase I Report*.  
[http://www.health.gov.on.ca/transformation/wait\\_times/providers/wt\\_strategy.html](http://www.health.gov.on.ca/transformation/wait_times/providers/wt_strategy.html).

MRI and CT Expert Panel (Anne Keller, Chair). 2006 (December 4). *Phase II Report*.  
[http://www.health.gov.on.ca/transformation/wait\\_times/providers/wt\\_strategy.html](http://www.health.gov.on.ca/transformation/wait_times/providers/wt_strategy.html).

Ontario Children's Health Network MRI/CT Subgroup (Cathy Séguin). 2006 (August 22). *OCHN MRI/CT Wait Times Task Force Report*.

## **APPENDIX A: EXPERT REVIEWERS AND GUIDELINE WORKING GROUP**

A small guideline working group developed a preliminary draft of the *Ontario Best Practice Guidelines for Managing the Flow of Patients Requiring an MRI or CT Examination*. This preliminary draft was reviewed by a broad range of expert clinical and administrative leaders. The invaluable input of these individuals is gratefully acknowledged.

### **Expert Reviewers**

1. Lydia Antalfy - Director of Diagnostic Imaging, Lakeridge Health Corporation.
2. Dr. Michael Barsky - Chief of Diagnostic Imaging, Credit Valley Hospital.
3. Bronwen Baylis - Manager Diagnostic Imaging, Hamilton Health Sciences, Henderson site.
4. Mary Ann Breitigam - Research and Special Projects Coordinator, Diagnostic Imaging Department, St. Joseph's Healthcare, Hamilton.
5. Lynne Campkin - Director, Diagnostic and Respiratory Services, Markham Stouffville Hospital.
6. Derek Coenen - Corporate Director of Diagnostic Imaging and EDS, Grey Bruce Health Services
7. Dorothy Genoe - Supervisor, Diagnostic Imaging, Sudbury Regional Hospital.
8. Karen Kennedy - Coordinator, MR/CT, University Campus, London Health Sciences Centre.
9. Harry Joseph - Director Diagnostic Imaging, Toronto East General Hospital
10. Veronica Nelson – Director of Diagnostic Imaging, Ross Memorial Hospital.
11. David Price - Director of Diagnostic Imaging, Queensway Carleton Hospital.
12. Diane Smith - Coordinator of Medical Imaging, St. Joseph's Health Care, London.
13. Dr. Graham Thomson - Interventional Radiologist, Hamilton Health Sciences, Henderson site.
14. Cheryl Tillmanns - Diagnostic Services Business Manager, Department of Diagnostic Services, Hamilton Health Sciences, Henderson site.
15. Dr. Brian Yemen - Radiologist, Henderson Site Chief, Department of Diagnostic Imaging, Henderson Hospital, Hamilton Health Sciences.
16. Dr. Robin Hesler - CEO, the Ontario Association of Medical Radiation Technologists.

### **Guideline Working Group**

Dr. Julian Dobranowski - Associate Clinical Professor, McMaster University Faculty of Health Sciences, Director, CORA (Centre of Radiological Anatomy), Lead Radiologist, Fluoroscopy & General Radiology, Medical Director, Imaging Research Centre Chair Provincial MRI and CT Expert Panel.

Steven Johansen, BA, LL.B. – Implementation Lead, Implementation Branch – Access to Care and Wait Times, Health System Accountability and Performance Division, Ministry of Health and Long-Term Care.

Aimee Langan, MHSc, MSc, PMP - Manager, Office of Strategy Management, The Joint Department of Medical Imaging, Mount Sinai Hospital, University Health Network, Women's College Hospital.

Joann Trypuc - Consultant to Ontario's Wait Time Strategy.

David Wormald - Integrated Assistant Vice President Diagnostic Services, St. Joseph's Healthcare Hamilton and Hamilton Health Sciences Corporation.

## **APPENDIX B: PHYSICIAN EDUCATION AND KNOWLEDGE WHEN ORDERING AN MRI OR CT**

General practitioners (GPs) and specialists who order MRIs and CTs should increase their education and knowledge about the appropriate use of these tests by:

- Referring to ordering standards and guidelines developed by expert groups such as the Canadian Association of Radiologists which published in 2005 *Diagnostic Imaging Referral Guidelines: A guide for physicians* ([www.car.ca](http://www.car.ca)). The guidelines were prepared by a CAR expert advisory committee in collaboration with the Canadian Association of Nuclear Medicine. The document is based on the Royal College of Radiologists' report *Making the Best Use of a Department of Clinical Radiology: Guideline for Doctors, fifth edition*. The American College of Radiology also provides a broad range of practice guidelines, technical standards and appropriateness criteria developed through consensus and review to assist clinicians ([www.acr.org](http://www.acr.org)).
- Attending continuing education courses on the appropriate use of medical imaging scans based on common clinical scenarios. GPs and specialists are encouraged to request these courses through their regulatory college and appropriate medical associations.
- Attending hospital-sponsored medical forums on appropriate ordering of diagnostic scans (e.g., changes in indications, patient safety, clinical appropriateness). Where these forums are not offered, GPs and specialists are encouraged to contact hospital diagnostic imaging departments and request that these forums be offered.
- Contacting a hospital diagnostic imaging department to request a consultation with a staff radiologist where there is a question about the appropriateness of a scan.

## **APPENDIX C: INFORMATION FOR PATIENTS ON MRI AND CT**

The Canadian Association of Radiologists (CAR) provides detailed information on MRI and CT on its website. CAR acknowledges the Radiological Society of North America (RSNA) and the American College of Radiology (ACR) for their permission to use the content of their information files in build the site: <http://www.radiologyinfo.ca>. The following information on MRI and CT for patients is taken from <http://www.radiologyinfo.ca>. Healthcare providers are encouraged to visit this excellent site for additional information to provide to patients on MRI and CT.

### **MR ANGIOGRAPHY (MRA)<sup>25</sup>**

#### **What is MR Angiography?**

Magnetic resonance imaging (MRI) is a method of producing extremely detailed pictures of body tissues and organs without the need for x-rays. The electromagnetic energy that is released when exposing a patient to radio waves in a strong magnetic field is measured and analyzed by a computer, which forms two- or three-dimensional images that may be viewed on a TV monitor.

MR angiography (MRA) is an MRI study of the blood vessels. It utilizes MRI technology to detect, diagnose and aid the treatment of heart disorders, stroke, and blood vessel diseases. MRA provides detailed images of blood vessels without using any contrast material. The procedure is painless, and the magnetic field is not known to cause tissue damage of any kind.

#### **What Are Some Common Uses of the MRA Procedure?**

Many patients with arterial disease now have it treated in the radiology department rather than undergoing surgery in an operating room. MRA is a very useful way of finding problems with blood vessels (blockages, blow-outs or abnormal connections) and determining how to best to treat those problems.

The carotid arteries in the neck that conduct blood to the brain are a common site of atherosclerosis, which may severely narrow or block off an artery, reducing blood flow to the brain and even causing a stroke. If an ultrasound study shows that such disease is present, many surgeons now will do the necessary operation after confirmation by MRA, dispensing with the need for catheter angiography.

MRA has found wide use in checking patients for diseased arteries in the head, so that only those with positive findings will need to have a more invasive catheter study.

MRA also is used to detect disease in the aorta and in blood vessels supplying the

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<sup>25</sup> This information is taken from <http://www.radiologyinfo.ca>.

kidneys, lungs and legs.

Patients with a family history of arterial aneurysm (a ballooning out of a segment of the vessel wall) can be screened by MRA to see if they have a similar disorder that has not produced symptoms. If an aneurysm is found, it may be treated either by surgery or endovascular therapy, potentially avoiding serious or fatal bleeding due to rupture of the aneurysm.

### **How Should I Prepare for the Procedure?**

The magnetic field used for MRA will pull on any iron-containing object in the body, such as a heart pacemaker, intrauterine device, vascular access port, metal plate, or pins, screws or staples. You will be given a questionnaire to answer regarding these issues. The radiologist or technologist should know about any such item and also whether you have ever had a bullet in your body, whether you ever worked with metals, or if you have had a joint replacement. If there is any question, an x-ray can be taken to detect metal objects. The radiologist also should know if you have fillings in your teeth, which could distort images of the facial region or brain. Braces make it harder to properly adjust the MRI unit. You will be asked to remove hairpins, jewelry, eyeglasses, hearing aids, and any dental work that can be taken out. Some wigs contain metal and must be removed. Red or blue dyes used in tattoos and permanent eyeliner may contain metallic iron, but this is rarely a problem. You should report any drug allergies to the radiologist or technologist, and should mention if there is any possibility that you might be pregnant.

You can eat normally before the exam (unless told differently), but a young child should not eat or drink for about four hours if they will receive a sedative. The rules vary at different MRI facilities, so be sure to check with your medical center about eating and drinking before the exam. Medications may be taken as usual. Some patients will feel uncomfortably confined (claustrophobic) when enclosed in an MRI unit. If necessary, you will be given a sedative to help put you at ease, though probably less than one in every 20 patients will need this. You will wear a lightweight medical gown for the exam.

### **What Does the MRI Equipment Look Like?**

The traditional MRI unit is a large tube surrounded by a circular magnet, in which the patient lies without moving for several seconds at a time. The patient is placed on a wheeled bed that is moved into the magnet. In recent years patient-friendly units have been designed, and examination in such units is becoming increasingly available. These machines are both shorter and wider than a conventional MRI unit, and do not fully enclose the patient. Some of the newer C-shaped units are even open on all sides, and so are very attractive to patients who tend toward claustrophobia. A drawback is that image quality is not as consistently good.

## **How Does the Procedure Work?**

Exposing the patient to radio waves in a strong magnetic field generates data that are used by a computer to create images of tissue slices. The magnetic field lines up atomic particles in the tissues called protons, which are then spun by a beam of radio waves and produce signals that are picked up by a receiver in the scanner. It is these signals that are processed by the computer to produce images. The resulting images are very sharp and detailed, and so are able to detect tiny changes from the normal pattern that are caused by disease or injury. Special settings are used to image various structures, such as arteries in the case of MRA.

## **How is the Procedure Performed?**

The patient is placed on a special table and positioned inside the opening of the MRI unit. A typical exam consists of two to six imaging sequences, each taking two to 15 minutes. Each sequence provides a specific image orientation and a specified degree of image clarity or contrast. Depending on the type of exam being done, the total time needed can range from 10 to 60 minutes, not counting the time needed to change clothing, have an IV put in and answer questions. When contrast material is needed, a substance called gadolinium is given by IV injection during one of the imaging sequences. It highlights blood vessels, making them stand out from surrounding tissues.

The radiologist and technologist leave the examining room during the actual imaging process, but the patient can communicate with them at any time using an intercom. Some centers permit a friend to stay nearby, or a parent if a child is being examined. When the exam is completed you will be asked to wait to make sure that more images are not needed.

## **What Will I Experience During the MRA Procedure?**

The technologist will make you as comfortable as possible, but at times the receiver or the magnet may be within a few inches of your face. For those who become very uncomfortable when enclosed in a small space, a mild sedative is nearly always effective. With certain sequences, you may notice a warm feeling in the area being studied. This is normal, but do not hesitate to report it if it bothers you. If you receive a contrast material injection there may be some local coolness at the IV site. The loud tapping, buzzing or knocking noises that are heard during the exam can be quite loud. This may disturb some patients; all patients are provided with earplugs to reduce these sounds and protect your hearing.

## **Who Interprets the Results and How Do I Get Them?**

A radiologist experienced in MRI will analyze the results and send a report to your physician, along with an interpretation of the findings. Your physician in turn will discuss the MRA findings with you. Some centers now send diagnostic reports and images over the Internet, speeding up the process.

## **What Are the Benefits vs. Risks?**

### ***Benefits***

- Detailed images of blood vessels and blood flow are obtained without having to insert a catheter directly into the area of interest, so that there is no risk of damaging an artery, or, in the case of the brain, causing a stroke.
- The procedure itself is shorter than after a traditional catheter angiogram. As well, there is no recovery time with the procedure, unlike the 4 to 6 hours needed for catheter angiography.
- MRA is less costly than catheter angiography.
- There is no exposure to x-rays during an MRI study.
- Contrast material may be injected to produce high-detail MR angiograms. The risk of an allergic reaction from MRA contrast is extremely low and kidney damage does not occur. This is different from catheter angiography or CT angiography, which make use of iodine-based contrast material, which has a much higher (though still small – less than 1 in 1,000) chance of some form of allergic reaction. In patients with kidney failure or poor kidney function, the iodine-containing contrast agents can worsen kidney function. Even without using contrast material, MRA can provide high-quality images of many blood vessels, making it very useful for patients prone to allergic reactions.
- As with catheter-based angiography or CT angiography, it may be possible to defer or cancel proposed surgery after getting the results of an MRA study. If surgery remains necessary based on the MRA, it can potentially be performed more accurately.

### ***Risks***

- There are no definite side effects from any type of MRI study, including MR angiography. Claustrophobia may be a problem, however. When it is severe and not relieved by giving a sedative, an alternative imaging method may have to be tried. If a metal implant is present but goes undetected, it may be affected by the strong magnetic field to which the patient is exposed. In addition, if the implant is close to the artery being examined it may be hard to get high-quality images.
- MRI generally is avoided during the first three months of pregnancy. Ultrasound is preferred at this time unless the woman might have a very serious condition that is best detected by MRA. If there are any effects of MRI on the fetus, none have been found as yet. The general rule for MRI and other diagnostic studies in pregnancy is that they should be avoided unless there is substantial risk from missing the correct diagnosis because the procedure is not done. Women who are breast-feeding should inform the radiologist and ask how to proceed. They may pump breast milk before the exam for use until the gadolinium contrast material has cleared from the body.

## **What are the Limitations of MR Angiography?**

MRA does not image calcium, X-ray and CT angiography do see calcium on the images.

The procedure has to be avoided in any patient having a pacemaker, some types of

aneurysm clip (older types contain large amounts of iron, which is magnetic), some types of implanted neurostimulator, metallic ear implant, or metallic object within the eyeball. It should also be avoided if there is a bullet fragment near or in the brain, heart or spinal cord. It may also be avoided if the patient has a port for delivering insulin or chemotherapy. For patients who are very claustrophobic, adequate nursing or medical staff must be on hand to monitor sedation.

The high-detail artery capability of MRA images does not yet match that obtained by x-ray catheter angiography. In particular, MRI of very small vessels may not be adequate for diagnosis and treatment planning, and regular catheter angiography will be needed. Occasionally it may be difficult to separate images of arteries from veins by MRA.

## **COMPUTED TOMOGRAPHY ANGIOGRAPHY (CTA)<sup>26</sup>**

### **What is CT Angiography?**

CT (computed tomography) angiography (CTA) is an examination that uses x-rays to visualize blood flow in arterial vessels throughout the body, from arteries serving the brain to those bringing blood to the lungs, kidneys, and arms and legs. CT combines the use of x-rays with computerized analysis of the images. Beams of x-rays are passed from a rotating device through the area of interest in the patient's body from several different angles so as to create cross-sectional images, which then are assembled by computer into a three-dimensional picture of the area being studied. Compared to catheter angiography, which involves placing a catheter and injecting contrast material into an artery, CTA is a much less invasive and more patient-friendly procedure-contrast material is injected into a peripheral vein rather than an artery. This exam has been used to screen large numbers of individuals for arterial disease. Most patients have CT angiography without being admitted to a hospital.

### **What Are Some Common Uses of the CT Procedure?**

- Examine the pulmonary arteries in the lungs to rule out pulmonary embolism, a serious but treatable condition.
- Visualize blood flow in the renal arteries (those supplying the kidneys) in patients with high blood pressure and those suspected of having kidney disorders. Narrowing (stenosis) of a renal artery is a cause of high blood pressure (hypertension) in some patients, and can be corrected. A special computerized method of viewing the images makes CT renal angiography a very accurate examination. Also done in prospective kidney donors.
- Identify aneurysms in the aorta or in other major blood vessels. Aneurysms are diseased areas of a weakened blood vessel wall that bulges out-like a bulge in a tire. Aneurysms are life-threatening because they can rupture.
- Identify dissection in the aorta or its major branches. Dissection means that the layers of the artery wall peel away from each other-like the layers of an onion. Dissection can cause pain and can be life-threatening.

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<sup>26</sup> This information is taken from <http://www.radiologyinfo.ca>.

- Identify a small aneurysm or arterio-venous malformation inside the brain that can be life-threatening.
- Detect atherosclerotic disease that has narrowed the arteries to the legs.

CTA also is used to detect narrowing or obstruction of arteries in the pelvis and in the carotid arteries bringing blood from the heart to the brain. When a stent has been placed to restore blood flow in a diseased artery, CT angiography will show whether it is serving its purpose. Examining arteries in the brain may help reach a correct diagnosis in patients who complain of headaches, dizziness, ringing in the ears, or fainting. Injured patients may benefit from CTA if there is a possibility that one or more arteries have been damaged. In patients with a tumour it may be helpful for the surgeon to know the details of arteries feeding the growth.

### **How Should I Prepare for the CT Procedure?**

Patients should be encouraged to drink fluids the evening before or the morning of the procedure to ensure they are well hydrated prior to the study.

Depending on the part of the body to be examined, you may be asked to take only clear liquids by mouth before CTA. You will be asked whether you have asthma or any allergies to foods or drugs, and what medications you are currently taking. If you are pregnant, you should inform the technologist before the procedure. You probably will not have to undress if you are having an exam of the head, neck, arms or legs but you will have to remove any jewellery, hair clips, dentures and the like that could show up on the x-rays and make them hard to interpret.

### **What Does the CT Equipment Look Like?**

A CT scanner is a specialized x-ray machine that looks like a large square doughnut. It has an opening measuring about two feet in diameter that surrounds a narrow table. Inside the frame of the scanner is a rotating device with an x-ray tube mounted on one side and a banana-shaped detector opposite it. Nearly all CTA studies use an advanced type of unit called a spiral CT machine that looks like any other type of CT unit, but is able to record a large number of pictures in a short time. This means that patients do not have to hold their breath for a prolonged period.

### **How Does the CT Procedure Work?**

Before the actual exam begins, you will have a dose of contrast material injected into a vein to make the blood vessels stand out. An automatic injector machine is used that controls the timing and rate of injection, which may continue during part of the time images are recorded.

During the examination, the rotating device spins around the patient, creating a fan-shaped beam of x-rays, and the detector takes snapshots of the beam after it passes through the patient. As many as one thousand of these pictures may be recorded in one

turn of the detector. The real work of CTA comes after the images are acquired, when powerful computer programs process the images and make it possible to display them in different ways, for instance, in cross-sectional slices or as three-dimensional "casts" of the blood vessels.

### **How is the CT Procedure Performed?**

Most of the time for a CTA examination is spent setting everything up. Actually recording the images takes only seconds. After changing into a hospital gown and having an IV set up, you will answer questions about things that might complicate the exam (such as allergies) and then will lie down on a narrow table. The part of your body to be examined will be placed inside the opening of the CT unit with the aid of criss-crossed positioning lights.

A test image is taken to determine the best position, and a small dose of contrast material is given to see how long it takes to reach the area under study. Then the IV is hooked up to an automatic injector, contrast material is injected, and the scan begins. Afterwards, the images will be reviewed and, if necessary, some will be repeated. No special measures are needed after the procedure.

### **What Will I Experience During the CT Procedure?**

CTA takes about 10 to 25 minutes from the time the actual examination begins. Overall, you can expect to be in or near the examining room for 20 to 60 minutes. You may feel warm all over when contrast material is injected before the scan, but you should not feel pain at any time. Any CT study requires that you remain still during the exam. Pillows and foam pads may help make it more comfortable. At the same time the nurse or technologist may use pads or Velcro straps to keep the area from moving. The examination table will move into and out of the scanner opening, but it is not enclosed and only a small part of your body will be inside at any one time. You may be asked to hold your breath for 10 to 25 seconds to be sure that the images will not be blurred. During the time that no actual imaging is taking place you are free to ask questions or talk to the technologist, but friends or relatives will not be allowed in the examining room. Once the needed images have been recorded, you will be free to leave. You can eat immediately and it is a good idea to drink plenty of fluids in the hours after the exam to help flush contrast material out of the system.

### **Who Interprets the CT Results and How Do I Get Them?**

Typically the results of CTA are available within 24 hours, although in complicated cases special computer analysis may take somewhat longer. The radiologist will report the findings to your physician, who in turn will discuss them with you.

## What Are the Benefits vs. Risks of CT?

### *Benefits*

- CTA can be used to examine blood vessels in many key areas of the body, including the brain, kidneys, pelvis, and the arteries serving the lungs. The procedure is able to detect narrowing of arteries in time for corrective surgery to be done.
- This method displays the anatomical detail of blood vessels more precisely than magnetic resonance imaging (MRI) or ultrasound. Today many patients can have CTA in place of a conventional catheter angiogram.
- CTA is a useful way of screening for arterial disease because it is safer and much less time-consuming than catheter angiography and is a cost-effective procedure. There also is less discomfort because contrast material is injected into an arm vein rather than into a large artery in the groin.

### *Risks*

- There is a risk of an allergic reaction-which may be serious-whenver contrast material containing iodine is injected. If you have a history of allergy to x-ray dye, your radiologist may advise that you take special medication for 24 hours before CTA to lessen the risk of allergic reaction. Another option is to undergo a different exam that does not call for contrast injection.
- CTA should be avoided in patients with kidney disease or severe diabetes because x-ray contrast material can further harm kidney function.
- If a large amount of x-ray contrast leaks out under the skin where the IV is placed, skin damage can result. If you feel any pain in this area during contrast injection, you should immediately inform the technologist.
- Women should always inform their doctor or x-ray technologist if there is any possibility that they are pregnant.

## What are the Limitations of CT Angiography?

CTA images of blood vessels anywhere in the body may be fuzzy if the patient moves during the exam or if the heart is not functioning normally. Blocked blood vessels also may make the images hard to interpret. CTA is not yet able to reliably image small, twisted arteries or vessels in organs that move rapidly. If you are breast feeding at the time of the exam you should ask your radiologist how to proceed. It may help to pump breast milk ahead of time and keep it on hand for use after CTA contrast material has cleared from your body. Pregnant women, especially those in the first three months, should not have CTA or any exam exposing them to x-rays.