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Appropriate Utilization of Advanced Diagnostic Imaging Procedures: CT, MRI, and PET/CT

Environmental Scan

Context

Currently, there is interest in the appropriateness of diagnostic imaging in Canada.[1] Evidence indicates that between 10% and 20% of medical imaging studies are unnecessary or inappropriate.[2] This environmental scan is intended to present some of the main issues pertaining to the appropriate use of advanced diagnostic imaging found in the literature.

Advanced diagnostic imaging procedures include computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography/computed tomography (PET/CT) imaging devices. This report addresses all three imaging modalities; however, because there are proportionately fewer PET/CT devices compared to CT devices and MRI devices in Canada (approximately 40,[3] 419,[4] and 222,[4] respectively), most of the references in this report relate to experiences with the latter two technologies.

In 2010, Canadians underwent 1.4 million MRI tests and 4.2 million CT tests — nearly double the number of each performed in 2003.[5] Between 2003 and 2007, MRI and CT use in the United States (US) Medicare population increased annually at a rate of 10.6% and 12.6%, respectively. During the same period, X-rays of the chest and bones increased annually by 1.3% and 3.4%, respectively.[6] The increased use of these technologies would not have been inappropriate in all cases; however, the following have been reported as some potential factors related to increased and/or inappropriate use:

- technological advances, which have broadened the range of clinical indications that advanced imaging tools can identify [7]
- an aging population[8]
- patient demand for advanced imaging technologies[7,9-12]
- the increased availability of the technology[8,9]
- a quick way for physicians to obtain information on a patient when physicians have increasing workloads[7,11]
- a practice of defensive medicine to avoid malpractice suits[7,9-11]
- physicians referring patients to imaging equipment that they have a financial stake in[13]
- lack of communication between clinicians, radiologists, and family physicians[9]
- gaps in knowledge of the ordering physician [14,15]
- excessive wait times for the most appropriate test [15]
- pressure to accelerate a patient's diagnosis, especially in an emergency setting.[16]

Determining the appropriateness of individual medical imaging procedures is a complex issue with many dimensions. Appropriateness may vary with the age, gender, size, and physical limitations of the patient. It may also vary depending on the condition and symptoms being investigated.[2]

Appropriate decision-making about diagnostic imaging can be further complicated by the rapid evolution of imaging technologies, clinically challenging patient cases, and difficult procedures. As well, as more medical specialists (such as, for example, cardiologists, obstetricians, rheumatologists, neurologists, and oncologists) are tending to order and interpret diagnostic imaging tests, and in some instances run imaging laboratories, this also complicates understanding the appropriateness of diagnostic imaging ordering practices.

It is likely that the use of advanced diagnostic imaging will continue to increase over the next decade due to the aforementioned factors. Other factors may also contribute to the continued growth of diagnostic imaging utilization. For example, expansion in CT use may be partially attributed to interest in it as a screening tool — specifically for lung cancer in smoking and ex-smoker populations, cardiac disease, and colon cancer populations.[17]

Similarly, the role of PET/CT will likely expand as new radiotracers become available that will broaden the range of clinical indications that can be diagnosed with imaging equipment.[18] Whether this potential increase in utilization results in an increased amount of inappropriate use remains to be seen.

Objectives

The purpose of this report is to provide information regarding the appropriate utilization of advanced diagnostic imaging. The following questions will be addressed:

1. What issues arise most frequently regarding the utilization of diagnostic imaging services?
2. What therapeutic areas/conditions are of most concern in the utilization of appropriate diagnostic imaging?
3. What is the role of the ordering physician, and is there a gatekeeper role or function identified in the literature for health care providers or for organizations that act to influence ordering practices both positively and negatively?
4. What is the role, if any, of legislation in driving appropriate utilization?
5. What is the role of payment schemes in driving appropriate utilization?
6. What is the role for quality assurance and accreditation in driving appropriate utilization?

Approach

It is not intended that the findings of this environmental scan provide a comprehensive review of the topic. Results are based on a limited literature search that was conducted using the Ovid MEDLINE bibliographic database. Grey literature was identified by searching a variety of websites. Some of the sources referenced in this report are opinion-based rather than evidence-based. The search was limited to English language documents published between January 1, 2007 and November 9, 2012.

Findings

1. What issues arise most frequently regarding the utilization of diagnostic imaging services?

The most commonly reported issue relating to the utilization of diagnostic imaging services pertains to patient safety. The increased volume of diagnostic imaging tests and the impact on health care finances and access, as it relates to wait times, are other notable concerns.

Patient Safety

There is increasing national and international concern regarding the harmful effects of radiation doses from CT tests,[19] particularly in the pediatric population, who are the most vulnerable to its effects.[20] While there is no direct evidence that ionized radiation from CT causes cancer,[21] it has been reported that CT imaging accounts for 1.5% to 2% of all cancers in the US.[22] The potential for developing cancer is believed to depend on the dosage used, with the risk increasing as the dose increases. In some instances, patients are accidentally over-exposed to excessive amounts of radiation that further increase their lifetime risk of developing cancer.[23]

In Canada, CT is used three times more frequently than MRI.[24] This is likely because there are twice as many CT devices compared to MRI devices. As well, health care providers may be referring some patients to CT in locations where access to MRI is limited even though MRI may, in some instances, be the imaging modality of choice for specific clinical indications. CT may also be used more frequently than MRI because it is less expensive and takes less time to perform.[24] While conventional X-ray also uses radiation, the doses associated with CT are generally higher.

Numerous strategies to reduce ionized radiation dosage in CT have been documented. In 2007, the Ontario Diagnostic Imaging Safety Committee for CT published a report that recommended that the province put in place various regulations to reduce CT-related radiation doses. The strategies suggested by the Committee included:

- shared responsibility between the referring clinician and radiologist on the use of CT
- the review of all requisitions for pediatric CT by a radiologist
- the recording and retention of doses for each CT test for audit
- encouraging manufacturers to ensure that the control console of CT scanners displays the dose of each CT exam.

As well, the Committee recommended the need for revisions to existing provincial legislation that included ensuring only individuals with appropriate clinical knowledge and training in radiation safety are permitted to prescribe or request CT tests.[25]

The implementation of dose registries is another strategy that can be used to improve patient safety. Dose registries can ensure that safe doses of radiation are administered during tests. In 2010, a pilot dose registry and radiation exposure monitoring project was established in Canada. The project — a collaboration between the National Research Council, Agfa HealthCare, Hamilton Health Sciences, and McMaster University — captures data on radiation exposure in patients undergoing diagnostic imaging tests such as CT, PET/CT, and X-ray. The data is intended to be used to measure the impact of repeated radiation on patients. Health care professionals and patients can use this information to make decisions about future diagnostic imaging tests and the medical need and associated risks of each procedure.[26]

In the US, the American College of Radiology piloted a Dose Index Registry in May 2011. The pilot project tracks medical imaging doses for CT studies that are submitted anonymously by medical imaging facilities and allows radiologists to track and compare dose indices of other facilities of similar size or geographic area. The radiologists receive feedback that compares their dose levels to national benchmarks, enabling them to make adjustments if necessary.[27]

The implementation of picture archiving and communication systems (PACS) can also be used to monitor CT radiation doses. The main purpose of PACS is to facilitate the electronic storage, retrieval, distribution, and presentation of images (including ultrasound, X-rays, CT, MRI, nuclear medicine, and mammography) in different locations and settings. Approximately 90% of radiologists use PACS in Canada. Once these systems are fully implemented across the country, it is believed that they will generate between $850 million and $1 billion annually in health system efficiencies.[28]

Other strategies to reduce ionized radiation dosage in CT include the use of:

- decision support software
- bismuth shields to partially block radiation
- automatic tube current modulation
- better reconstruction algorithms
- calculation of radiation doses for possible reporting
- the provision of patient information material
- review of CT protocols

- the active involvement of medical radiation technologists to ensure that protocols are followed
- the promotion of alternative non-ionizing studies.[29]

As well, newer CT-based technologies are being used that use a fraction of the radiation dose required by conventional CT scanners.[30]

Because MRI does not use ionizing radiation to produce images, safety issues for this modality are mostly limited to thermal burns and hearing loss in poorly protected patients.[31] MRI can pose risks to patients with metallic implants and certain other implanted materials. Magnetic field interactions produced by the MRI scanner may cause the sudden and forceful movement of a device. Adherence to comprehensive screening procedures and protocols ensures that technologists and radiologists are informed of the presence of these devices.[32]

Some patients with renal insufficiencies or renal dysfunctions who receive gadolinium-based contrast agents during the MRI scan may be at an increased risk of developing nephrogenic systemic fibrosis.[33]

MRI taken close to prostheses will produce a reduced image quality.[34] Patients with claustrophobia may experience feelings of anxiety due to the confined nature of some MRI scanners.[35]

Increased Volume of Requisitions for Diagnostic Imaging Tests

There have been numerous reports of an increased use of advanced diagnostic imaging tests both nationally and internationally.[11,24] According to a 2005 Statistics Canada survey, approximately 4.3% of all Canadians aged 15 and older had had a non-emergency CT scan in the past 12 months, and approximately 3.9% of Canadians had had a non-emergency MRI scan during the same period.[24] In Ontario alone, the number of CT and MRI tests increased by 300% and 600%, respectively, between 1993 and 2003.[36]

There are anecdotal reports that family physicians ordering MRIs may placate patients by also ordering CT or other diagnostic imaging tests, in addition to an MRI, because these tests are associated with significantly shorter wait times. Conversely, as a result of the long wait times associated with MRI, some physicians may avoid the test altogether and order alternative diagnostic imaging tests that are less appropriate but more accessible. It is also reported that physicians trained in health centres where there is high use of diagnostic imaging tend to order more diagnostic imaging tests compared to physicians trained in low-use centres. As well, more experienced physicians tend to order fewer tests than newer physicians.[37]

There is also a perception that the increased use of diagnostic imaging may be partially attributed to the view that some physicians regard diagnostic imaging as an alternative to a comprehensive review of a patient's medical history and a detailed physical exam.[38] The Canadian Medical Imaging Team Day supports the need for an adequate review of a patient's clinical history by the ordering physicians. The more comprehensive the information provided in an initial request, the Team claims, the greater the likelihood that a diagnostic imaging test can be undertaken in the most appropriate and timely manner.[2]

In the United Kingdom (UK), patient demand for diagnostic imaging tests, specifically CT and MRI, has increased significantly over the past decade.[12] However, the National Health Service (NHS) does not currently have sufficient information to assess the appropriate use, cost, performance, and capacity of diagnostic imaging services. To help identify this information, the NHS and the Department of Health implemented a Diagnostic Imaging Dataset (DID) that was launched in April 2012. The DID captures detailed information about all

diagnostic imaging tests carried out on NHS patients. It is estimated that this national repository will help compare unit costs and benchmark performances. It will enable the identification of the reasons for large variations in utilization across NHS trusts and overutilization practices.[39] The information captured in the dataset will hold health trusts accountable for their performance and may encourage efficiency.[12]

While no health technology assessments, systematic reviews, or meta-analyses have been found that assess the impact of the overutilization of diagnostic imaging services,[40] overutilization is known to put strains on finite health care finances and, in the case of CT procedures, exposes patients to unnecessary radiation doses.

Overutilization has been defined as the use of diagnostic imaging procedures where circumstances indicate that they are unlikely to improve patient outcome.[14] While overutilization of diagnostic imaging services has been reported in Canada, according to the Health Council Canada, it is difficult to ascertain the reasons why and to what extent it actually occurs.[28]

Repeat imaging is another cause of increasing diagnostic imaging. There are estimates that between 7% and 15% of all diagnostic imaging tests are unnecessary duplications because pre-existing images are available.[41] A 2007 study by the Commonwealth Fund reported that 20% of all patients surveyed claimed they had undergone repeat imaging. The number of Canadian patients who reported repeat imaging was 8%. In the UK, 9% of participants reported repeat imaging, in New Zealand it was 10%, in Australia it was 15%, and, in Germany, it was 16%.[14]

The escalated use of imaging has also been associated with the potential for "treatment cascades." Treatment cascades refer to the use of diagnostic imaging that subsequently leads to procedures that may be of low value to patients.[42] Researchers at Stanford Medical Center found that locations in the US with high concentrations of MRI devices have a higher number of patients receiving MRI tests for lower back pain, and consequently a higher number of people undergoing back surgeries. The study found that each additional MRI device in a given location leads to 40 additional MRI tests, and that 3,500 needless back surgeries could have been avoided if the MRI devices were not available.[43]

Inappropriate use of diagnostic imaging also puts an unnecessary strain on already overburdened wait lists. Reducing wait times for diagnostic imaging services is considered a priority in most provinces.[44] A 2011 Canadian Institute for Health Information (CIHI) report on Canadian wait times ranked CT and MRI imaging tests as one of five priority areas. Wait times for MRI were regarded as being longer than those for CT, with half of all MRI patients waiting between 31 and 77 days. CT patients waited between 7 and 22 days for a scan. The increased wait time for MRI is likely related to the fact that there are approximately half as many MRI devices as CT devices in Canada (222 compared to 419, respectively).[4]

According to the Canadian Wait Time Alliance, the benchmark wait time for emergency, CT, and MRI cases is 1 to 24 hours. For urgent cases, the benchmark wait time for CT and MRI is 1 to 7 days, and, for scheduled cases, both occur within a 30-day time frame.[45]

A 2009 Canadian survey of wait times in publicly funded MRI facilities found that, while 96% had some method for triaging MRI requisitions, only 42% had documented guidelines for prioritization and none used quality assurance practices to ensure guidelines were followed. Strategies for managing wait times did not address inappropriate requisitions and were largely centred on attempts to build capacity.[46] The recent growth in the use of advanced imaging services has raised national

expenditures on imaging in most countries.[47] Spending for diagnostic imaging in Canada has increased and now exceeds an estimated $2.2 billion in operational costs. The elimination of 10% of unnecessary tests is estimated to potentially create savings of $220 million each year.[48]

According to the Canadian Medical Imaging Team Day, the following factors should be considered when ordering diagnostic imaging tests:[2]

- Is the medical imaging requested consistent with available medical imaging guidelines related to the patient's clinical condition and history?
- Which medical imaging modalities are available and accessible within an acceptable time frame?
- Which medical imaging modality will allow the medical imaging team to acquire the information needed by the ordering health care provider, while using the least amount of radiation?
- Which medical imaging modality will be the most cost-effective for the health care system?

2. What therapeutic areas/conditions are of most concern in the utilization of appropriate diagnostic imaging?

The areas of greatest concern in advanced diagnostic imaging tests discussed herein relate largely to the use of ionized radiation. Children and pregnant women are the most vulnerable to the effects of ionized radiation delivered through CT and PET/CT exams.

CT

Guidelines recommend that experienced radiologists provide sound clinical justification before imaging children or pregnant women in the pelvic/abdominal regions with CT. As well, alternative imaging technologies such as MRI and ultrasound should be considered, where appropriate.[34]

Common uses of CT included neurology, cardiology, oncology, angiography, virtual endoscopy, orthopedics, and trauma.[49] Approximately 90% of all Canadian CT scans for outpatients are for head, abdomen, chest, and spine tests.[50]

CT is believed to play an important role in the diagnosis of trauma.[34] This is largely because of its clinical usefulness in situations where time restrictions do not allow for a delay in imaging, when anesthesia restrictions limit access to MRI, or when large body parts need to be imaged quickly.[51]

The Ontario Diagnostic Imaging Safety Committee for CT has recommended that diagnostic reference levels for head, chest, and abdominal/pelvic CT should be established by members of professional medical bodies. Once established, the diagnostic reference levels should be disseminated and reviewed periodically.[25]

MRI

Because MRI does not use ionizing radiation, it may be considered first in situations where both CT and MRI provide similar information and where both modalities are available. According to the latest Canadian Association of Radiologists (CAR) guidelines, the most suitable clinical applications of MRI include: adult and pediatric brain, head and neck, adult and pediatric spine, abdomen and pelvis, musculoskeletal system, cardiovascular, chest, breast imaging, and fetal imaging.[52] Over 80% of all Canadian MRI tests for outpatients are of the head, spine, and extremities.[50]

PET/CT

In Canada, the main application of PET/CT scanning is in oncology, where it is used for the diagnosis, staging, and/or detection of recurrent disease. Across Canada, the most popular uses of PET in oncology are for lung, esophageal, breast, colorectal, and thyroid cancers. PET is used less widely for cardiology and neurology disorders.[3] Outside of Canada,

PET/CT is also commonly used to diagnose neurological, infection/inflammation, and cardiology-associated conditions.[53]

3. What is the role of the ordering physician, and is there a gatekeeper role or function identified in the literature for health care providers or for organizations that act to influence ordering practices both positively and negatively?

Ordering Physician

According to the Health Council of Canada, family physicians are regarded as the gatekeepers to Canada's entire health care system, including diagnostic imaging services.[28] The increase in the overall use of advanced diagnostic imaging has, in part, been attributed to the growth in referrals from family physicians, as some jurisdictions now permit orders from them. Previously, only specialists were allowed to order these procedures.[28] The gatekeeper function for diagnostic imaging is different across Canada and depends on a variety of factors. A referral for an advanced imaging test may be made by either a family physician or specialist, depending on the policies of regional health authorities, the geographic location of an ordering physician, the availability of radiologists, and the clinical reason for ordering the test. Some specialists will also supervise, perform, and interpret test results.[4]

Medical students, chiropractors, and nurse practitioners can order diagnostic imaging tests in some jurisdictions.[28] There is anecdotal evidence that in jurisdictions where family physicians are not authorized to refer patients to diagnostic imaging services, they are still routinely requesting these procedures.

A 2003 report by the Ontario Institute for Clinical Evaluative Sciences on access to MRI found that neurologists ordered the greatest proportion of all MRI tests, constituting 24%, followed by family physicians who ordered 20%, orthopedic surgeons at 17%, and neurosurgeons with 8%.[54]

A lack of ordering physician knowledge is a factor that can contribute to ineffective utilization.[15] In Canada, radiology courses are not a compulsory component of medical school training for general practitioners. Formal university training on radiation dosing and appropriate utilization for all medical students and resident trainees may play a role in alleviating the inappropriate use of diagnostic imaging.

In the UK, there are restrictions on who can refer patients for different types of diagnostic imaging services. Neither general practitioners or junior hospital doctors have the authority to order diagnostic imaging tests.[47] Currently, general practitioners refer patients to hospital consultants. Following an outpatient appointment with a patient, the hospital consultant requests a diagnostic imaging procedure. After the test, the patient returns to the consultant who plans the treatment program.[55]

However, as part of the UK Department of Health's new Modernisation of Health and Care program, patients will be allowed to access diagnostic imaging services directly through their general practitioners. It is estimated that this new approach will reduce wait times for diagnostic imaging tests from up to 18 weeks down to 3 weeks. As well, it is anticipated that the adoption of this new program will free up hospital consultants' time for patients with serious conditions. It will also allow patients to be managed within a primary health care setting, which is believed to provide more convenience and is less expensive than alternatives.[55] It remains to be seen if this new program will impact the appropriateness of advanced diagnostic imaging practices, or if it will help reduce wait times for diagnostic imaging services.

In Australia, over 65% of requests for diagnostic imaging are made by general practitioners.[56] In recognition of the significant increase in the use of diagnostic imaging by general practitioners, the Cancer Council Western Australia developed a four-page resource card to educate and assist it when discussing diagnostic imaging with patients. In 2011, the resource card was distributed to 1,700 general practitioners within the region. A follow-up questionnaire was distributed three months later and showed that 86% of the polled general practitioners found the resource card to be useful. As well, 90% of the general practitioners discussed the risks and benefits of imaging with their patients — an increase of 20% from the time the resource card was initially distributed.[57]

In 2010, a Norwegian survey of 93 family practitioners was conducted to determine their knowledge of radiation doses and the associated risks to patients for commonly requested imaging tests. The survey found that family practitioners who underwent radiation safety training at medical school were significantly more knowledgeable about the subject than those who received no training. Overall, family practitioners reported a low level of awareness of radiation doses, and generally underestimated them and their associated risks. More than 40% of the responders were not aware that MRI and ultrasound do not use ionized radiation.[58]

Radiologists

The traditional role of Canadian radiologists is to supervise medical imaging practices and interpret test results for the diagnoses and treatment of patients.[4] They may also play a role in determining the appropriate use of imaging services. It has been argued that their superior clinical and technological expertise in radiation exposure puts them in a position where they should be playing a greater role in the decision-making process for safe imaging, especially in the areas of appropriateness and patient safety issues.[59,60]

According to a 2007 article by Knechtges on the evolving responsibilities of radiologists, their role has expanded beyond generating and interpreting diagnostic imaging tests. Radiologists now play a role as economic gatekeepers who can ensure that resources are used effectively and appropriately. Radiologists can also act as political advocates, patient safety advisors, promoters of continuous quality improvement, and information technologists. However, the author notes that clinical productivity pressures and, in the case of information technology, large start-up costs can discourage radiologists from embracing these roles.[61]

It is claimed that some radiologists actually contribute to overutilization because they do not routinely review orders for appropriateness before they are conducted.[14,51] In the absence of reviewing all requisitions for diagnostic imaging, it has been suggested that the burden of inappropriate use might be better contained if radiologists were to review some requisitions more routinely, particularly those that are costly or expose patients to high levels of radiation. There is support for radiologists taking on the role of child advocates in setting the standard for safe and effective pediatric imaging.[51] There is also support for radiologists to communicate directly with patients about the benefits and risks of radiation exposure.[62]

It has been implied that inappropriate use might be reduced if communication between radiologists and ordering physicians occurred more frequently and effectively. A survey of family physicians, specialists, and radiologists from Ontario, on diagnostic imaging practices, found that there was a lack of communication between ordering clinicians and radiologists, both at the time of initially ordering the test and also at the time the test results are reported back to the ordering physician. Radiologists claimed that it was difficult to provide definitive interpretations of test results in the absence of background information on patients. Similarly, ordering physicians stated

that it was difficult to open lines of communication with radiologists due to busy schedules, the relocation of radiologists, and administration changes within imaging departments. It was noted that both radiologists and ordering physicians showed disdain for each other and blamed inappropriate use on each other.[9]

The Australian government is currently assessing the role of radiologists in appropriate imaging, with the aim of expanding their involvement with patient management. A review will be undertaken that will involve working with imaging requesters and providers to improve communication flow and give radiologists more clinical information on patients. Regulations that limit imaging substitutions will also be reviewed, with the aim of removing barriers to clinically appropriate imaging.[56]

In the UK, the Royal College of Radiologists provides good practice guidance to help reduce the overutilization of diagnostic imaging services. The College recommends that clinical radiology departments undertake frequent audits of practices that are associated with significant risk. The audit helps to identify significant deviations from accepted standards and can be used to develop a plan for remedial action. Audits should include an assessment of appropriateness or indication, safety or complication rates, and minimum efficacy rates.[63]

Other Roles and Functions

Specialists may also influence diagnostic imaging ordering, as some are increasingly ordering, supervising, and reading imaging tests. Some specialities also provide guidelines on best practices and appropriate use criteria for diagnostic imaging.[64,65]

According to guidance from the Canadian Cardiovascular Society on the use of cardiac CT, any clinician who understands the risks and benefits of CT can recognize the risks and benefits of alternative imaging modalities, and should be able to request a cardiac CT and use the results to positively direct patient management.[66] Oncologists,[67-69] obstetricians,[70] and rheumatologists[71] are among the physician specialists who provide recommendations and/or clinical practice guidelines for diagnostic imaging.

According to the Canadian Association of Medical Radiation Technologists (CAMRT), radiation technologists play a significant role as patient safety advocates, as they ensure patients receive appropriate diagnostic imaging tests.[72] CAMRT's Code of Ethics[73] states that radiation technologists are obliged to implement only those procedures which, in their clinical experience and judgment, are in the patient's best interest. This is achieved by assessing the completeness of requisitions and ensuring they include information pertaining to the patient's condition, history, and previous diagnostic imaging tests.[72] If a radiation technologist identifies discrepancies between the medical imaging procedure that has been requested and the patient's history, the radiation technologist should follow up with the most appropriate medical professional to ensure that the most appropriate medical imaging procedure is performed.[74]

Public and private health insurers may also play a gatekeeping role in diagnostic imaging ordering practices because they make decisions regarding which tests to fund. Currently, Canadian health ministries only fund PET/CT for a limited number of conditions for which there is a strong evidence base. The main application for PET/CT is in oncology, where it is used for the diagnosis, staging, and/or detection of recurrent disease. A case-by-case review process is in place to accommodate situations where a strong case for a PET/CT is made but the evidence does not yet support widespread use.[3]

Similarly, provincial physician associations may influence imaging ordering, as they negotiate fee schedules, set provincial standards, and provide guidance.

Improved communication and cooperation between all the stakeholders involved in diagnostic imaging — including radiologists, technologists, sonographers, ordering physicians, medical physicists, insurers, policy-makers, patients, and industry — will likely play a role in addressing inappropriate imaging use and patient safety issues.

4. What is the role, if any, of legislation in driving appropriate utilization?

Currently, there is no specific Canadian federal legislation that addresses appropriateness in medical imaging. However, Health Canada has developed a series of safety codes to set out requirements for the safe use of radiation-emitting equipment for large radiological facilities.[75]

Some provincial legislation also pertains to safety issues, and some provincial chapters of professional colleges, societies, and associations provide recommendations, guidance, and/or standards. For those provinces that haven't created documentation that addresses appropriate imaging practices, there is general agreement that this issue needs to be addressed — if not at the jurisdictional level, then at a national one. The CAR provides criteria on appropriate imaging practices.[48]

A 2007 report by the Ontario Diagnostic Imaging Safety Committee for CT recommended that the province adopt dose management and optimization strategies. The committee also suggested revisions to the existing Ontario *Healing Arts Radiation Protection (HARP) Act*. Chief amongst these revisions would be the stipulation that only health practitioners with appropriate clinical knowledge and training in radiation safety should be permitted to prescribe or request CT tests. As well, it was recommended that routine testing and inspection of CT scanners should be incorporated into the Act.[76]

In the US, federal legislation has played a significant role in reducing inappropriate ordering. The 2005 *Deficit Reduction Act*'s imaging-related clauses were implemented as a result of escalating costs attributed to imaging. These clauses required outpatient imaging operators to adopt lower payments for the technical components of imaging exams.[77] In the first full year that the Act took effect, Medicare's imaging spending was reduced by 12.7% .[78] The Act is also believed to have impacted sales of CT and MRI scanners, which declined by 36%.[79]

A provision of the *Medicare Improvements for Patients and Providers Act*, passed in 2008, required the accreditation of all imaging facilities by 2012 as a condition for reimbursement.[14]

The US 2010 *Patient Protection and Affordable Care Act* further reduced physician fees for imaging by 25% and required physicians who have a financial interest in an imaging technology to inform their patients of this interest and provide a list of alternative facilities.[79]

The UK has radiation protection legislation in the form of the *Ionising Radiation (Medical Exposure) Regulations 2000 Act*. The main legal requirements are enforced through the UK Health and Safety Executive and are framed to protect patients from unintended or unjustified radiation exposure. The legislation requires that clinical radiology departments must record the professionals from whom they will accept referrals and produce appropriate referral criteria. Sufficient medical data is required before a practitioner can assess the justification for a procedure. This process allows radiologists to restrict referrals for certain types of tests to specific individuals or grades of health care professionals. It is believed that this legislation

improves the quality of clinical information provided for requisitions for imaging procedures involving ionizing radiation and in so doing helps reduce unnecessary investigations.[80]

5. What is the role of payment schemes in driving appropriate utilization?

Funding methods for diagnostic imaging depend on the technology being used and the jurisdiction where the procedure is taking place.[4] There are usually variations between how physicians' professional fees are funded and how hospital or other facility operational fees are funded. For example, many physicians are reimbursed for services using the fee-for-service payment method, while hospitals are reimbursed mostly through global budgets. PET/CT in Canada, unlike CT or MRI in Canada, is funded by health ministries only for specific clinical indications and this has proven to be a strong driver for appropriate utilization.

Hospital- and physician-funding mechanisms are believed to influence the delivery and quality of patient care. Fee-for-service hospital funding is not considered to be a promising option in Canada because it rewards volume.[81] Similarly, fee-for-service physician funding is associated with overutilization of diagnostic imaging services.[82] In May 2012, the Government of Ontario implemented physician fee reductions. While this decision was reported to be made primarily to save money across all provincial physician services, an 11% fee reduction for 250 diagnostic radiology tests over four years, as well as a 50% reduction in "self-referral fees" (a practice that involves physicians referring patients back to their own practices for diagnostic imaging testing) may also impact appropriate utilization practices. At this time, there is uncertainty on the impact that physician fee reductions will have on the quality of patient care.

In 2009, participants of a summit hosted by the American Board of Radiology Foundation discussed the causes and effects of overutilization. They identified a variety of payment systems, including fee-for-service, that contribute to diagnostic imaging overuse.[14] Physician self-referring was also recognized as a practice that contributes to the increased volume of diagnostic imaging. A meta-analysis published in 2011 found that, in the US, non-radiologist self-referring clinicians are 2.48 times more likely to order diagnostic imaging tests than clinicians with no financial incentive in imaging. The cost of this imaging to Medicare was estimated to be billions of dollars annually.[78] Summit participants discussed an alternative payment approach that involved realigning economic incentives to an approach that rewards evidence-based practice and preferred outcomes.[14]

The US Medicare Payment Advisory Commission (MedPAC) recommended to Congress that a bundled payment mechanism should replace the existing fee-for-service system. A bundled payment is a predetermined fixed amount for each patient hospitalization episode. It is believed that this payment model will give physicians and hospitals increased incentive to prevent overutilization of diagnostic imaging services.[83] Opponents of this payment system claim that it could potentially lead to hospitals cutting services to the bare minimum, and cherry-picking the healthiest and thereby the cheapest patients.[84] As well, this method does not account for regional and diagnostic differences in costs, a factor that could potentially leave some doctors out of pocket.[85]

Prior authorization is another payment scheme that can influence appropriate utilization. This payment mechanism requires ordering physicians to receive authorization from insurance companies and/or their agents before a patient's diagnostic imaging test can be performed. Physicians cannot be reimbursed for the procedure without this prior approval.[10] Supporters of this process claim that it improves the quality of patient care and creates

health care savings because there are checks and balances in place.[10] Critics believe that the process lacks transparency, is disruptive to the clinical work flow, and is administratively and financially burdensome.[86] There is also the belief that physicians (with an understanding of patient medical histories), and not health insurers, should be responsible for decisions relating to patient care. One of MedPAC's recommendations to Congress was that practitioners who order substantially more advanced imaging services than their peers should be required to partake in a prior authorization program.[87]

Prior notification is another payment scheme that can influence appropriate utilization. Like prior authorization, prior notification requires ordering physicians to contact insurers before patients undergo diagnostic imaging tests. Health insurers using this approach believe it encourages physicians to select the most appropriate tests based on individual patients' clinical circumstances.[88]

Australia is currently revising its funding methods for diagnostic imaging. In 2012, the Australian government published a report entitled *Review of Funding for Diagnostic Imaging Services*. The purpose of the report was to establish appropriate fees for the Medicare Benefits Schedule and review current funding arrangements for different diagnostic imaging modalities, as well as develop alternatives to fee-for-service funding mechanisms.[56]

In 2002, the UK's Department of Health introduced a form of activity-based funding, known as payment by results (PbR). This new funding model marked a fundamental change in the way in which certain hospital activities, including diagnostic imaging testing, are reimbursed. PbR is believed to reward efficiencies, support patient choice, and reduce wait times.[89] Critics of this funding model claim that, like the bundled payment mechanism, PbR achieves efficiencies by hospitals picking healthy patients, or by reducing the level of resources in the provision of care, which subsequently lowers the quality of the patient care.[90] Some high-cost drugs, devices, and procedures are excluded from PbR. For example, PET/CT and SPECT/CT are not funded through PbR, whereas PET remains within the scope of PbR.[47]

It has been suggested that hospitals can improve the quality, utilization, and costs of diagnostic imaging services by providing financial incentives to physicians who observe standard protocols and increase their communication and collaboration between ordering physicians and radiologists.[91]

6. What is the role for quality assurance and accreditation in driving appropriate utilization?

There is a general acceleration of efforts by governments and professional colleges to promote appropriate utilization of medical imaging through credentialing and quality assurance practices. This is mostly due to reporting of medical imaging errors across Canada.

Alberta is currently reviewing medical quality assurance processes for diagnostic imaging testing after interpretation errors were discovered in three facilities across the province in less than two months.[92] In 2012, the Alberta College of Physicians and Surgeons published updated standards and guidelines for diagnostic imaging.[93]

A similar investigation took place in British Columbia in 2011 when its Ministry of Health Services requested an independent investigation into the quality of diagnostic imaging after errors in four health authorities came to light.[94] Two reports by the British Columbia Patient Safety & Quality Council were the outcome of this investigation. One of these reports included recommendations for the minimization of errors, which included a provision of a peer-review process for CT scans,

the development of health authority diagnostic imaging quality assurance committees to provide oversight for diagnostic imaging services, and the creation of a standardized process across all health authorities for medical staff appointment, credential review and privileging, and physician review.[94] British Columbia has also established a Provincial Privileging Steering Committee to guide the process of establishing core, non-core, and context-specific privileges on a province-wide basis. Radiology is the first specialty to undergo this process, which includes input from radiologists from various health authorities and with various subspecialty expertise. The intended outcome of this initiative is to arrive at a consistent, fair, and criteria-based privileging process. The reappointment and performance review process will also be included as part of the overall initiative. A steering committee for performance review is now being composed, and the first draft of a terms of reference is being considered. The Vancouver Island Health Authority and Vancouver Coastal Health have already established peer review processes for diagnostic imaging.[95] In 1971, British Columbia established the Diagnostic Accreditation Program (DAP) through the provincial College of Physicians and Surgeons. The DAP currently assesses the quality of diagnostic services through accreditation activities, peer review approaches to accreditation, knowledge sharing, and professional support.[96]

In Saskatchewan, the College of Physicians and Surgeons of Saskatchewan (CPSS) provides leadership in the areas of quality standards in diagnostic imaging specifically in relation to the professional practice of radiologists and nuclear medicine physicians. The College's Quality Assurance Program aims to review the performance of every physician engaged in diagnostic imaging at three-year intervals. The review involves the random selection of diagnostic imaging tests done by the physician that will be reviewed by a number of peers. The peer reviewers submit a report of their observations to the Advisory Committee on Medical Imaging (ACMI) of the CPSS. After a review of the report, the ACMI shares the report with the physician under review and, if necessary, provides recommendations for improvement. If the ACMI identifies specific areas of concern, it may review the physician's practice more quickly to ensure that the recommendations have been implemented. [97]

The College of Physicians & Surgeons of Manitoba oversees the operation of diagnostic imaging standards through the Manitoba Quality Assurance Program (MANQAP), which was set up in 2007. The primary function of MANQAP is to establish standards for diagnostic facilities, to investigate and inspect diagnostic facilities for accreditation, to ensure member compliance with established standards, and to encourage the adoption of national and international best practices.[98] In 2011, MANQAP published new standards governing diagnostic imaging facilities.[99]

Most provinces have experienced problems with diagnostic imaging errors. However, because the majority of jurisdictional quality assurance programs are facility-based and are specific to the size of the facility, the make of the imaging equipment, and the scope of the facility's practice, it is difficult to standardize diagnostic imaging practices, even at a local level.

There are also accreditation processes for specific imaging modalities. The Canadian Association of Radiologists offers an accredited program for mammography. This voluntary program offers radiologists the opportunity for peer review and evaluation of their facility's staff qualifications, equipment performance, quality control and quality assurance programs, image quality, breast dose, and processor quality control.[100]

In Ontario, the Cardiac Care Network (CCN) is dedicated to improving quality, efficiency, access, and equity in the delivery of adult cardiac services in Ontario. The CCN has a

mandate to monitor adult cardiac services in the province and develop strategies to enhance the quality of cardiac care. In this role, CCN develops and implements strategies based on evidence and best practices to better manage cardiovascular disease across the continuum of care. As one of the key components of quality maintenance, the CCN is working with stakeholders, with a focus on appropriateness for cardiac diagnostic imaging testing and intervention, to ensure that systems are in place to monitor and report on relevant metrics.[101]

The Australian government is working on improving the appropriate use of diagnostic imaging services by strengthening the power of the Diagnostic Imaging Accreditation Scheme (DIAS). The DIAS will be introducing stricter quality and safety standards for practitioner credentialing, practice and patient safety, professional supervision requirements, management of patient radiation dose, and other areas that affect the appropriate use of diagnostic imaging services.[56]

In the UK, an Imaging Services Accreditation Scheme (ISAS) was developed in 2009 to create an accreditation process to support radiology services in delivering higher quality patient-focused services. It was jointly established with the Society and College of Radiographers and is being run for the two colleges by the United Kingdom Accreditation Service (UKAS). The ISAS is intended to promote best practices by comprehensively addressing patient experience, clinical effectiveness, patient and staff safety, and efficient use of resources.[102]

There may be a role for the automation of quality assurance in diagnostic imaging. It is believed that objective data can be retrieved through the development of quality assurance algorithms that detect and quantify its deficiencies. This data could be used to create universal standards and a structured quality assurance database.[103]

Appropriateness criteria can be used as a quality assurance strategy to help alleviate overutilization. Appropriateness criteria are evidence-based guidelines that assist ordering physicians and other providers in making the most appropriate imaging decision for a specific clinical condition. The use of these guidelines can improve ordering physicians' quality of care. However, knowledge of appropriateness criteria tools is generally not widespread and their use is voluntary. The American College of Radiology has developed appropriateness criteria,[104] CAR has tested the effectiveness of providing its *Diagnostic Imaging Referral Guidelines* through computerized clinical decision support and computerized provider order entry systems, as part of appropriateness projects,[48] and the UK's Royal College of Radiologists[105] and the European Union[34] have imaging referral guidelines.

Appropriateness criteria have been developed by some medical specialities. The Canadian Cardiovascular Society developed appropriateness guidance for cardiac CT.[66] In the US, the American Colleges of Cardiology and Radiology published joint appropriateness guidelines for cardiac CT and MRI.[106]

Evidence-based practice guidelines and recommendations have been developed to help guide appropriate clinical decision-making. However, physicians do not always follow guidelines. A 2009 survey of 25 US physicians on the application of practice guidelines found diversity in use. Some physicians found guidelines highly useful and implemented them often, while others found them not very useful and rarely, if ever, used them.[7] Some physicians found guidelines to be inaccessible and confusing. Others found guidelines to be too generalized to be applicable to atypical patients. There was concern that not all guidelines can be applied to populations who do not commonly take part in clinical trials, such as children, the elderly, and those with multiple comorbidities. As well, many physicians felt that when dealing with the individual needs of their patients, their

own judgment and expertise was better than generic, third-party guidelines.[7]

The implementation of guidelines use was a factor that led the Canadian Council of the Federation to launch an initiative to encourage greater consistency in clinical practice guideline use. This work became part of the Health Care Innovation Working Group process under the auspices of the Clinical Practice Guidelines Theme Group. The group is currently working toward a collaborative process by which specialty groups can work together in the development and dissemination of evidence-based guidelines.[107]

Clinical decision support systems provide immediate guidance to physicians on the appropriateness of diagnostic imaging tests and therefore may have a role to play in quality assurance. Clinical decision support tools can be accessed through web portals, computerized order entry systems, or via electronic health records so that they can be used as part of the normal workflow. Clinical decision support systems are not used extensively in Canada. CADTH published a report on this topic in January 2012.[108]

CAR conducted two studies in Manitoba to test the usability of clinical decision support systems for diagnostic imaging. One study at the Children's Hospital in Winnipeg reviewed 8,757 orders that were placed through the decision support software in one year. The results showed that the decision support software did not have a big impact on physicians' ordering practices, with advice from the decision support only being followed in 2% of cases. Nineteen per cent of orders had relevant guidelines, 10% of orders were inappropriate, and less than 1% of all inappropriate orders were avoided. It was also noted that the new process affected the time to order a diagnostic imaging test depending on the setting. Physicians in an outpatient setting noted that results were received more rapidly under the new process, whereas emergency room physicians noted that the new process increased the time it took to place the order. As well, it was noted that while the information received through the new system was more clear and standardized, it lacked the contextual information necessary to complete the most appropriate test.[15]

The second Manitoba study assessed the acceptance of decision support in a rural community family practice over a 36-week period. The decision support system identified 24% of the orders as inappropriate and physicians followed suggestions from decision support to improve their diagnostic imaging order in 25% of the initially inappropriate orders. It was noted that, while physicians supported the concept of clinical decision support, the perceived disruption in workflow created by it affected its implementation.[109]

Four US studies assessed the impact of integrating clinical decision support systems into computerized order entry. Three of them reported decreases in the volume and rate of inappropriate use of CT and MRI due to decision support system implementation.[110-112] It is unclear whether decision support software created by third party vendors in the US will provide appropriate contextualized solutions for the Canadian health care system.
In Australia, decision support tools were recommended by the Australian Diagnostic Imaging Association to cope with rapid changes in diagnostic imaging. The association suggests that decision support tools should be made available on the desktops of all referring physicians as a means of assuring that all imaging requisitions are appropriate.[113]

Initiatives around accountability for decisions made regarding the selection of specific diagnostic imaging tests may impact ordering practices. Decision support tools that log every action taken in the diagnostic imaging process can prevent a physician from proceeding with a test until a peer review consultation is conducted.[114]

In 2011, a systematic review on the impact of computerized order systems on imaging services and patient outcome found imaging departments experienced efficiency gains, improved test selection, improved test appropriateness, and cost savings with incorporating computerized order systems. Most of these benefits were associated with the integration of decision support tools.[115]

Credentialing of imaging equipment and physicians who interpret imaging tests is another strategy that can affect utilization. Information sharing between health ministries, health authorities, and professional colleges on accredited staff will help ensure that only trained staff are conducting and reading diagnostic imaging tests. As seen in the US, legislation that requires providers to undergo a privileging process to receive reimbursement has gone some way to reducing inappropriate diagnostic imaging.

Discussions around quality assurance and accreditation should also include imaging processing laboratories. In many Canadian jurisdictions, local Colleges of Physicians and Surgeons are responsible for ensuring that quality standards are maintained in laboratories. It has been suggested that, as part of maintaining quality standards, laboratories should ensure that staff understand appropriate use criteria and develop a process to reduce the number of inappropriate referrals.[116] As well, facilities, equipment, and supplies should be routinely checked to ensure the safe and efficient performance of diagnostic imaging services.

Conclusion

Demand for diagnostic imaging services continues to rise globally. It is unclear if the rise in demand results in a higher percentage of inappropriate use. The main issues, identified in this environmental scan, that arise from inappropriate use relate to patient safety, the impact on health care finances, and wait times. Appropriate utilization of diagnostic imaging services is influenced by a number of factors that include, but are not limited to, physician test ordering practice and diagnostic imaging funding mechanisms, as well as quality assurance and accreditation practices.

This environmental scan was posted for stakeholder feedback. Valuable input was received from health ministries, national/provincial physician associations and societies, various health care providers, and industry. Most of the feedback was based on the front line experiences of stakeholders and was not supported with referenced material.

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