

# IHE Report

## CT and MRI Services in Alberta: Comparisons With Other Health Care Systems

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**IHE**

INSTITUTE OF  
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# ■ CT AND MRI SERVICES IN ALBERTA: COMPARISONS WITH OTHER HEALTH CARE SYSTEMS

**Prepared by:**

David Hailey

Institute of Health Economics

## ■ THE ONE PAGE SUMMARY

### **The issue**

Computed tomography (CT) and magnetic resonance imaging (MRI) are widely used in medicine. There is interest in how well Alberta is making use of these expensive, essential technologies. Points to consider include numbers and types of scanners in the province, how frequently CT and MRI are used and wait times for services.

### **The findings**

Alberta has a network of CT and MRI scanners with a distribution across the province that includes smaller centres of population.

The number of CT scanners per population is lower than for most other provinces and than the mean value for OECD countries. Alberta has more MRI scanners per population than all other provinces except Québec and is above the mean for OECD countries.

Number of CT exams per population in Alberta is close to the average for Canadian jurisdictions, less than that for US hospitals and higher than for several European countries. The number of MRI exams per population is higher than for any other province and for several European countries, and lower than that for US hospitals.

The annual number of exams per CT scanner in Alberta is well above the average for Canada, and also higher than for England, US hospitals, and 11 European countries. The annual numbers of MRI exams per scanner is close to the average for Canada. The Alberta rate is higher than those for US hospitals, England and nine European countries.

Wait times for CT exams are close to or at provincial access goals. The mean Alberta wait time is similar to those for Ontario and England. The mean wait time for MRI exams is higher than the wait times in Ontario, England and eleven European countries. Wait times in Alberta are well above the provincial access goals for all urgency categories.

There is limited information on the extent to which CT and MRI services provide value for money to health care systems.

## **Policy considerations**

Comparison with other jurisdictions suggests that Alberta is performing well in terms of frequency of use of CT and MRI scanners.

Wait times for MRI exams are high in comparison to those for other health systems and demand for MRI exams is higher in Alberta than in other provinces and several European countries.

Options for decreasing wait times for MRI exams include increasing the number of scanners, their hours of operation, and reducing demand. Increasing capacity would depend on availability of staff and other priorities for funding in health care. Reducing demand might be assisted by promoting use of guidelines for the appropriate use of MRI and avoiding duplication of exams because of poor communication within the health system. Such measures would also increase the value for money of CT and MRI services.

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## ■ INTRODUCTION AND SUMMARY

This report presents summary information on computed tomography (CT) and magnetic resonance imaging (MRI) in Alberta, with comparison to the use of these diagnostic imaging technologies in other jurisdictions.

The aims of this report are to:

- illustrate the capacity in Alberta to diagnose and manage health problems with the help of these important technologies
- compare the numbers, age and utilization of CT and MRI scanners in Alberta, and the wait times for MRI and CT exams, with those in other health systems
- draw attention to issues related to the safety and value for money of CT and MRI services

Both national and international perspectives have been taken for these comparisons.

This overview is consistent with the health action plan announced by the Alberta Minister of Health and Wellness, which builds on the 2006 *Health Policy Framework – Getting on with Better Health*.

### **Sources and reliability of information**

Information on CT and MRI services in the province has been obtained primarily from data collected by Alberta Health and Wellness and the Canadian Institute for Health Information (CIHI). Publications prepared by CIHI have been the main sources of data for other Canadian jurisdictions and a variety of sources have been used to obtain data on CT and MRI in other countries.

Comparisons of the use of CT and MRI services in different jurisdictions are limited by the availability and quality of relevant data. Data limitations for Canadian surveys of medical imaging technologies have been summarised by CIHI. (CIHI, 2006a) Dates, methods of data collection and definitions vary considerably among the different information sources. Any comparison of the Alberta experience with that in other health systems should be made with caution.

### **Findings of the review**

#### **Number of scanners**

Alberta has a network of CT and MRI scanners with a distribution across the province that includes smaller centres of population.

At the start of 2007 there were 12 CT scanners per million population, which is lower than the rate for most other provinces and below the Canadian mean of 12.8 per million. The Alberta rate was also lower than the mean value for

OECD countries and the rates for several European countries. By mid-2008 the Alberta rate had increased to 12.6 per million.

At the start of 2007, Alberta had 7.9 MRI scanners per million population, which was the second highest rate for all Canadian provinces. This rate was also above the mean for OECD countries and is similar to the rates for several European countries. By mid-2008 the Alberta rate had increased to 9.1 per million.

### **Type and age of equipment**

The average age of CT scanners in the province is 3.5 years, which is lower than the mean for all Canadian jurisdictions. As in other provinces, the large majority of the units are spiral CT scanners. The proportion of CT scanners that are less than 6 years old is higher than in ten European countries.

The average age of MRI scanners is 5.6 years, which is close to the mean value for all provinces. The proportion of MRI scanners that are less than 6 years old is lower than the Canadian average. It is also lower than the proportions for nine European countries. As is the case in other Canadian provinces, the large majority of MRI scanners are high magnetic field strength units.

### **Services per population**

Number of CT exams per population in Alberta (108 per 1000) is close to the average for Canadian jurisdictions, less than that for US hospitals, and higher than for several European countries. Number of MRI exams per population (41 per 1000) is higher than for any other province and than in several European countries, and lower than in US hospitals.

### **Operation of scanners**

On average, CT scanners in Alberta are operated for 65 hours per week. This is above the average for all Canadian jurisdictions and is higher than that for US hospitals. Scanners in larger Alberta facilities are operated for 112 hours per week.

MRI scanners are also operated for an average of 65 hours per week, lower than the average for all provinces of 71 hours per week and than the average for US hospitals. Scanners in larger Alberta facilities operate for an average of 93 hours per week.

The number of exams per CT scanner in Alberta during 2005/06 was 9588, well above the average for Canada and similar to the rate for Ontario. The rate for Alberta is higher than those for England, US hospitals and ten European countries.

The number of MRI exams per scanner in 2005/06 was 5015, just above the average for Canada. Ontario, Nova Scotia and New Brunswick had higher rates of use. The Alberta rate was higher than those for US hospitals, England and

nine European countries. In 2007, the Alberta rate increased to 5,600 exams “per scanner, which was higher than all provinces except Ontario.

### **Wait times**

People in Alberta who need emergency CT or MRI scans receive them without delay.

Wait times for CT scans in other cases average 3 weeks and are close to or at provincial access goals for all urgency categories. Comparison with other health systems is difficult, because available data are limited, but the mean Alberta wait time appears to be similar to those for Ontario and England. The mean wait time is higher than those reported for seven European countries, and lower than three others.

The mean wait time of 9 weeks for MRI exams is higher than the wait times in Ontario, England, and eleven European countries. Wait times in Alberta have decreased since the beginning of 2007, but remain well above the provincial access goals for all urgency categories.

### **Patient safety**

Use of CT is associated with a risk of inducing cancer as a result of exposure of patients to ionizing radiation. Individual risks are small and have to be balanced by the substantial benefits associated with use of CT, including more effective patient management and avoidance of invasive procedures. Nevertheless, there is concern that increased use of CT may create a future public health issue. Use of CT should be undertaken in accordance with guidelines from regulatory and professional bodies, with particular caution when pediatric patients are being examined.

### **Value for money**

It is difficult to judge the value for money (VFM) of all the CT and MRI services undertaken within a jurisdiction, or to compare VFM between different jurisdictions. Recent Canadian assessments concluded that evidence of clinical or economic benefit from use of CT and MRI for the investigation of 13 medical conditions remains limited. (Foerster, 2005, Murtagh, 2006). Also, available cost-effectiveness studies provide only an imperfect indication of VFM in a limited number of applications and may not relate to the reality of how CT and MRI are being used routinely.

### **Policy-related issues**

In 2007, Alberta had fewer CT scanners per population than most other Canadian jurisdictions but more MRI scanners per population than all other provinces except Québec. As noted by CIHI in relation to Canadian diagnostic imaging data, high (or low) rates of scanners per unit of population do not necessarily mean high (or low) rates of exams.

Comparison with the use of CT and MRI in other provinces and in other countries suggests that Alberta is performing well in terms of annual number of exams per scanner. Also, types and ages of CT and MRI scanners in Alberta are similar to those in other provinces, though the proportion of MRI scanners less than 6 years old is relatively low. There appear to be no concerns regarding the standard of equipment.

However, the experience with wait times for exams differs for the two imaging technologies. Although Alberta has comparatively few CT scanners, wait times are at or close to provincial targets, and similar to those in Ontario and England.

The situation is different for MRI. Although Alberta has the second highest number of scanners per population in Canada and a high number of exams per scanner, wait times remain well above provincial targets. The wait times are high in comparison to those for Ontario and several European countries. Alberta has a higher demand for MRI services than other provinces and some European countries.

Options for decreasing wait times include increasing capacity through acquiring additional scanners and/or increasing hours of operation. Such approaches would need to be balanced by consideration of availability of staff to operate the scanners and priorities for funding in other areas of health care. Also, increasing hours of operation may not be realistic for scanners in smaller centres of population.

Other options might focus on reducing demand. Reducing demand could be assisted by promoting use of guidelines for the appropriate use of MRI (and CT). Prioritization guidelines developed by a joint committee (from Alberta Health & Wellness, the Alberta Society of Radiologists, and Regional Health Authorities) to maximize the effective utilization of diagnostic imaging services are helpful. Attention should also be given to reducing the proportion of CT and MRI exams that are duplicated because of poor communication between different parts of the health system. Such measures would also increase the VFM of CT and MRI services.

Views on the appropriate level of use of CT and MRI will be shaped in part by the nature of the health care system, economic factors, and societal preferences. The wide range in scanners per population in different countries suggests a need to steer between the contrasting disadvantages of shortage of essential diagnostic imaging services and overcapacity and inefficient use of expensive facilities.

■ CT AND MRI: WHAT ARE THEY?

Computed tomography (CT) and magnetic resonance imaging (MRI) are versatile imaging techniques used to investigate a variety of symptoms and for treatment planning and monitoring. They are widely used in medicine and are two of a range of diagnostic imaging technologies that includes X-ray, nuclear medicine, and ultrasound methods.

Both technologies use tomographic methods to create cross-sectional and three-dimensional images of the body. In CT, the image is created from computer processing of X-rays passing through the body. In MRI, images are produced by placing the patient in a magnetic field, delivering radiofrequency pulses to the patient, and processing the resulting electromagnetic signals emitted from the region being examined.

Both CT and MRI have evolved over many years as new types of scanners became available. For example, the development of spiral CT, with a gantry that rotates continuously, permits more rapid exams and improvement in image quality, compared to earlier types of scanner. There is also increasing use of CT in combination with the nuclear medicine technology positron emission tomography (PET).

MRI scanners are often classified in terms of the field strength of their magnets, measured in Tesla (T). There has been a trend towards increasing use of high magnetic field strength (1.5T) MRI scanners for many types of examinations, and systems with magnetic field strength of 3.0T are becoming established in routine diagnostic services.

■ CT AND MRI: WHAT ARE THEY USED FOR?

CT and MRI provide complementary diagnostic information. The majority of CT exams are for scans of the abdomen, while most MRI exams involve scans of the brain and spine. The following table shows the proportions of different types of scan for each of the technologies in Ontario for 2004/05.

Types of CT and MRI exams in Ontario, 2004/05

CT exams		MRI exams	
Type of scan	Per cent of total scans	Type of scan	Per cent of total scans
Abdomen/ pelvis	61.9	Brain	33.7
Brain	38.5	Spine	29.9
Thorax	18.4	Extremities	24.8
Spine	10.5	Others	11.6
Others	4.7		

Source: Laupacis et al., ICES, 2006

Survey results on the reasons for CT and MRI exams in Canada are shown below. Use of MRI in the joints and fractures category is increasing, consistent with the 32% increase in scans of the extremities reported for Ontario. (Laupacis et al., 2006)

**Reasons for tests for Canadians aged 15 and over who reported receiving a non-emergency CT or MRI in the past 12 months**

Reason for test	CT			MRI		
	2001	2003	2005	2001	2003	2005
Heart or stroke disease	7%	7%	7%	-	9%	7%
Cancer	13%	9%	11%	-	6%	4%
Joints or fractures	13%	16%	16%	18%	35%	35%
Neurological or brain disorders	29%	19%	18%	12%	14%	19%
Others/not specified	37%	37%	48%	46%	35%	35%

Sources: Health Services Access Surveys 2001, 2003, and 2005, Statistics Canada. (cited by CIHI 2006a)

## CT AND MRI SERVICES IN ALBERTA

### Numbers of scanners

The locations of 43 CT scanners and 31 MRI scanners in Alberta at August 2008 are listed in the following table, grouped by location in the former health regions. There are also three PET/CT units in Edmonton and Calgary, which have not been considered in the following discussion. Three MRI scanners at the In Vivo NMR Centre at the University of Alberta are used only for research and have not been included.

Distribution of scanners in the province includes 16 CT and 8 MRI scanners that are outside Edmonton and Calgary.

# CT and MRI scanners in Alberta and their locations, 2008

Region/city	Location	CT scanners	MRI scanners
Chinook	Lethbridge Regional Hospital	1	1
Palliser	Medicine Hat Regional Hospital	1	1
Calgary	Foothills Medical Centre	3	5
	Rockyview General Hospital	2	1
	Richmond Road Centre	1	1
	Peter Lougheed Centre	2	1
	Alberta Children's Hospital	1	1
	South Calgary Health Centre		1
	Sheldon M. Chumir Health Centre	1	
	Radiology Consultants Associated, Mayfair Diagnostics	1	1
	MYK Diagnostic Imaging		1
	Canada Diagnostic Centres, Chinook Centre	1	1
	EFW Radiology, Holy Cross site	1	
	High River General Hospital	1	
	Canmore General Hospital	1	
	Banff Mineral Springs Hospital		1*
	Alberta Cancer Board, Tom Baker Cancer Centre	2	
David Thompson	Red Deer Regional Hospital	2	1
	Central Alberta Medical Imaging Services, Red Deer		1
	Drumheller Health Centre	1	
	Wetaskiwin Hospital & Care Centre	1	
East Central	St. Mary's Hospital, Camrose	1	
	Mobile MRI		0.5**

\* Extremities imaging

\*\* Mobile scanner, joint venture between Aspen and East Central

## CT and MRI scanners in Alberta and their locations, 2008 (continued)

Region/city	Location	CT scanners	MRI scanners
Edmonton	University of Alberta Hospital & Stollery Children's Hospital	3	2
	Royal Alexandra Hospital	2	1
	Grey Nuns Community Hospital & Health Centre	1	1
	Misericordia Community Hospital	1	1
	Alberta Hospital, Edmonton	1	
	Medical Imaging Consultants, Edmonton		2
	Insight Medical Imaging, Edmonton	1	1
	Sturgeon Community Hospital, St. Albert	1	
	Alberta Cancer Board, Cross Cancer Institute	3	2
Aspen	Cold Lake Healthcare Centre	1	0.5**
	Hinton Healthcare Centre	1	
	Westlock Healthcare Centre	1	
Peace Country	Queen Elizabeth II Hospital, Grande Prairie	1	1
	Peace River Community Health Centre	1	
Northern Lights	Northern Lights Regional Health Centre, Fort McMurray	1	1

\*\* Mobile scanner, joint venture between Aspen and East Central

Sources: CPSA 2008, CIHI 2008

## Scanners per population

The table shows numbers of scanners per million population for each region, and for Alberta, in 2008. Scanners operated by the Alberta Cancer Board are assumed to provide services for the whole province.

## Numbers of scanners that are used clinically per million population, 2008

Region	# CT	Scanners/ million	# MRI	Scanners/ million
Chinook	1	1.5	1	1.5
Palliser	1	1.0	1	1.0
Calgary	15	1.2	14	1.3
David Thompson	4	1.3	2	0.7
East Central	1	0.9	0.5*	0.4*
Edmonton	10	1.0	8	0.8
Aspen	3	1.7	0.5*	0.6*
Peace Country	2	1.5	1	0.8
Northern Lights	1	1.4	1	1.4
Alberta Cancer Board	5		2	
Alberta	41	1.2	31	1.0

\* Assumed that the mobile scanner is assigned 50% each to Aspen and East Central

## CT and MRI equipment

Most of the CT scanners in the province were spiral CT machines (38 of 43 scanners). Thirty-four of these were in hospitals or health centres and four were in free standing facilities. The remaining scanners were non-spiral machines, four located in hospitals, and one in a free standing facility.

Most of the MRI scanners in Alberta were high field strength machines (twenty five 1.5T units and two 3T scanners), all with closed bores. There was also one 1.0T scanner, one 0.4T unit with an open bore, an open bore extremity scanner, and a closed bore scanner in a mobile unit.

Twenty-three scanners were in hospitals or health centres and seven in free standing facilities. The mobile MRI scanner provides services at five locations in Aspen and East Central.

## Age of equipment

Details of the age of CT and MRI scanners in Alberta at the start of 2007 are shown below. A survey of radiologists in Alberta found that age of equipment, availability of equipment parts, and the maintenance of equipment were not regarded as major problems in their clinical practices. (Triska, 2007)

## Age profile of scanners in Alberta

		Number (%) of scanners in different age groups		
		< 6 years	6 – 10 years	> 10 years
CT scanners	3.6 years	32 (78)	6 (18)	1 (3)
MRI scanners	5.6 years	10 (36)	17 (61)	1 (3)

Source: CIHI, 2008

## How frequently are CT and MRI services used?

The 2007 CIHI survey found that for Alberta there were 108 CT exams per 1000 population and 41 MRI exams per 1000 population. (CIHI, 2008) In 2006/07 the average number of exams per machine was about 10,502 for CT and 5616 for MRI.

Average hours of operation per week in 2006/07 were 65 both for CT and for MRI scanners. (CIHI, 2008) In 2006, CT units in smaller facilities operated approximately 44 hours per week and those in larger facilities for 112 hours weekly. Rates for MRI scanners were 46 hours per week for small facilities and 93 hours per week for larger facilities. (Triska, 2007)

## Wait times for CT and MRI services

People in Alberta who need emergency exams receive them without delay. They are not entered on a waitlist. Totals under persons served include those who voluntarily delayed their procedure or test, and those who had a scheduled follow up procedure.

Most of the information in this section is taken from the Alberta Waitlist Registry, administered by Alberta Health and Wellness. Data are obtained for wait times in public facilities; most of the public hospitals or clinics with scanners participate.

## Definitions for wait times in Alberta

A wait time starts when the patient and ordering physician decide that a service is required and ends when the service is provided.

An access goal is a performance goal for Alberta. It is a wait time within which a region must strive to provide 90% of selected elective services. Access goals are developed for three urgency categories by clinical experts and approved by the Minister of Health and Wellness.

The 90th percentile wait time is the wait time in weeks within which 90% of patients were served. It includes data from persons served during the 90 days prior to the report date.

## CT exams

Data were available from 25 participating facilities.

In August 2008, median wait time for the province was 1.3 weeks, and 75.7% of patients had a wait time of less than 3 weeks. There were 9759 patients on wait lists at August 31, 2008 and 20,889 had received services in the 90 days preceding that date.

There has been little variation in wait times since January 2007:

	Wait time, weeks			
	January 2007	June 2007	January 2008	June 2008
90th percentile	7	5	6	6
Mean	3	3	3	3
Median	1.4	1.6	1.4	1.3

Values for 90th percentile wait times at June 2008 were close to or had met provincial access goals:

Urgency category	90th percentile wait time				
	Provincial access goal	January 2007	June 2007	January 2008	June 2008
I : For more urgent conditions	1 week	2 weeks	5 weeks	6 weeks	6 weeks
II : For less urgent conditions	4 weeks	5 weeks	4 weeks	5 weeks	5 weeks
III : For elective conditions	8 weeks	12 weeks	9 weeks	8 weeks	8 weeks

Source: Alberta Waitlist Registry

## MRI exams

Data were available from 20 participating facilities, five of which are using the mobile MRI scanner.

In August 2008 the median wait time in Alberta for MRI exams was 5.9 weeks. There were 25,097 patients on wait lists on August 31, 2008 and 15,135 had received services in the 90 days preceding that date.

Wait times had decreased since January 2007:

	Wait time, weeks			
	January 2007	June 2007	January 2008	June 2008
90th percentile	24	23	22	20
Mean	12	11	10	9
Median	11	10	7	6

Wait times are above the provincial access goals for all urgency categories:

Urgency category	90th percentile wait time				
	Provincial access goal	January 2007	June 2007	January 2008	June 2008
I : For more urgent conditions	1 week	6 weeks	7 weeks	6 weeks	5 weeks
II : For less urgent conditions	4 weeks	19 weeks	17 weeks	14 weeks	9 weeks
III : For elective conditions	12 weeks	26 weeks	27 weeks	24 weeks	22 weeks

Source: Alberta Waitlist Registry

## Other wait list information for Alberta

A publication by the Fraser Institute reports median wait times for Alberta in 2006, based on a national hospital wait list survey, of 4.0 weeks for CT exams and 9.0 weeks for MRI exams. The value for MRI exams is close to that from the Waitlist Registry of 9.1 weeks, while the CT value is twice that from the registry (2.0). The basis for the Fraser Institute's estimates is "prospective median waiting times for elective procedures from the specialist's decision to treat the patient". (Esmail et al., 2006)

# ■ HOW DOES ALBERTA COMPARE WITH OTHER PROVINCES?

## Numbers of scanners

As of January 1, 2007, there was one MRI scanner for every 1.9 CT scanners in Canada. Saskatchewan had the lowest ratio of MRIs to CTs (1:3.8), while Alberta had the highest ratio, with one MRI scanner for every 1.5 CTs. Quebec had the most MRIs per million population (8.7). Alberta has the next highest number of MRIs per population (7.9) but fewer CTs (12.0) than most jurisdictions. (CIHI, 2008)

At August 2008, Alberta had 12.6 CT scanners and 9.1 MRI scanners per million population.

Number of scanners and number of scanners per million population, by jurisdiction, January 1, 2007

CT scanners			MRI scanners		
	Number	rate/million		Number	rate/million
Y.T.	1	32.3	Que.	67	8.7
N.W.T.	1	23.6	Alta.	27	7.9
N.L.	11	21.6	P.E.I.	1	7.2
N.B.	15	20.0	Man.	8	6.8
N.S.	16	17.1	N.B.	5	6.7
Man.	19	16.1	N.S.	6	6.4
Que.	119	15.5	N.L.	3	5.9
Sask.	15	15.2	B.C.	25	5.8
P.E.I.	2	14.5	Ont.	72	5.7
Alta	41	12.0	Sask.	4	4.0
B.C.	49	11.3			
Ont.	130	10.2			
Canada	419	12.8	Canada	222	6.8

Source: CIHI, 2008

## Ratios of MRI to CT scanners for different jurisdictions

Ratios of MRIs to CTs in hospitals and free-standing facilities, January 2007

Ratio MRI: CT	
Sask.	1: 3.8
N.L.	1: 3.7
N.B.	1: 3.0
N.S.	1: 2.7
Man.	1: 2.4
P.E.I.	1: 2.0
Que.	1: 1.8
Ont.	1: 1.8
B.C.	1: 1.7
Alta.	1: 1.5
Canada	1: 1.9

Source: CIHI, 2008

# Location and type of scanners

In Canada, the number of MRIs in free-standing (or non-hospital) imaging facilities has grown every year since 1998 and the number of CT scanners in free-standing facilities has grown every year since 2000. As of January 2007, about 5% of CTs and 18% of MRIs were in free-standing facilities. (CIHI, 2008)

Information on the location and type of CT scanners by jurisdiction is shown below. Spiral CTs are the dominant type of scanner in all jurisdictions.

Location, type and age of CT scanners by jurisdiction, 2006

	Hospital	Free standing	Spiral CT, % of total
N.L.	10	0	80
P.E.I.	2	0	100
N.S.	15	0	80
N.B.	10	0	90
Que.	95	9	73
Ont.	111	3	89
Man.	16	0	94
Sask.	14	0	71
Alta.	35	3	85
B.C.	45	2	77
Y.T.	1	0	100
N.W.T.	1	0	100

Source: CIHI, 2006b

The age of CT scanners in hospitals is shown below. The age of equipment is generally low, with only 7% being older than 10 years. The mean age of scanners in Alberta is lower than the national mean and the proportion of scanners aged 0-5 years is higher than the mean value for all jurisdictions.

**Age of CT scanners in hospitals, 1 January 2007**

	0 – 5 years	6-10 years	> 10 years	Mean age in years
PEI	100%	-	-	3.0
NB	87%	7%	7%	3.6
Ont	79%	18%	2%	3.6
Alta	76%	24%	0%	3.5
Sask	73%	20%	7%	4.1
Man	68%	32%	0%	4.3
BC	60%	36%	4%	4.5
NL	55%	45%	0%	5.1
NS	50%	31%	19%	6.5
Que	49%	36%	16%	6.2
Canada	66%	27%	7%	4.6

Source: CIHI, 2008

Location and type (field strength) of MRI scanners by jurisdiction in 2006 are shown below. High field strength (1.5T) scanners are dominant in all jurisdictions.

**Location, type and age of MRI scanners by jurisdiction, 2006**

	Hospital	Free standing	Field strength				
			< 0.5T	0.5T	1.0T	1.5T	≥ 3.0T
N.L.	2					2	
P.E.I.	1					1	
N.S.	4	1			1	4	
N.B.	7				4	3	
Que.	38	15	5		7	40	1
Ont.	61	2	2		2	57	2
Man.	7	1	1	1		6	
Sask.	4				1	3	
Alta.	20	4	1		1	20	2
B.C.	11	8	2	1	3	13	

Source: CIHI, 2006b

Details of the age of MRI scanners in hospitals are shown below. The mean age of scanners in Alberta is close to the mean value for all jurisdictions, but the proportion of scanners aged 0-5 years is lower.

**Age of MRI scanners in hospitals, 1 January 2007**

	0 – 5 years	6-10 years	> 10 years	Mean age in years
NL	100%	0%	0%	2.7
PEI	100%	0%	0%	4.0
NS	80%	20%	0%	3.6
BC	75%	15%	10%	4.5
Que	58%	25%	17%	5.9
Man	57%	43%	0%	5.4
Ont	49%	46%	4%	5.3
Alta	33%	62%	5%	5.6
Sask	25%	75%	0%	6.5
NB	20%	80%	0%	5.6
Canada	54%	38%	8%	5.4

Source: CIHI, 2008

# Utilization of services

Numbers of CT exams and MRI exams per 1000 population for each jurisdiction are shown below. New Brunswick had the highest rate of CT exams and the Northwest Territories had the lowest. Alberta had the highest rate of MRI exams per 1000 population and Newfoundland and Labrador the lowest.

Number of CT and MRI exams per 1,000 population, by jurisdiction, 2006–2007

CT exams		MRI exams	
	Exams/ 1,000		Exams/ 1,000
NB	177	Alta.	41
NS	140	Ont	35
NL	135	NB	32
Sask	133	Man	32
PEI	70	Que	29
Man	112	NS	26
Que	110	BC	21
Alta	108	Sask	22
Ont	95	PEI	20
BC	86	NL	17
YT	69		
NWT	67		
Canada	103	Canada	31

Both hospitals and free-standing facilities.

Source: CIHI, 2008

## Numbers of exams per scanner

Annual numbers of CT and MRI exams per scanner for each jurisdiction are shown below. Alberta was above the national average for numbers of CT exams per scanner. In 2006/07, Alberta was also above the national average for number of exams per MRI scanner, after been close to the average in previous years.

### Annual numbers of exams per scanner, by jurisdiction

CT exams per scanner				MRI exams per scanner			
	2004/05	2005/06	2006/07		2004/05	2005/06	2006/07
Alta	9,800	9,588	10,502	Ont	6,500	6,466	6,979
NB	9,200	10,350	10,150	Alta	5,000	5,015	5,616
Sask	7,500	7,062	9,950	Sask	5,500	4,950	5,462
Ont	10,000	9,777	9,523	NS	9,500	5,640	4,950
NS	7,600	10,152	8,735	NB	4,500	5,250	4,920
Que	6,600	7,103	8,000	Man	4,000	3,688	4,770
BC	7,200	7,777	7,785	Que	4,200	4,071	3,930
Man	8,000	7,211	7,210	BC	3,500	3,400	3,231
NL	5,000	5,980	6,210	NL	4,200	3,120	2,847
PEI	4,800	7,770	4,828	PEI	2,100	2,660	2,839
NWT	1,900	1,920	2,788				
YT	1,500	2,040	2,105				
Canada	8,034	8,374	8,735	Canada	5,168	4,944	5,123

Source: CIHI 2005, 2006c, 2008

## Hours of operation per week

In 2006/07 Alberta on average operated both CT scanners and MRI scanners for 65 hours per week. National averages were 60 hours per week for CT scanners and 71 hours per week for MRI scanners. (CIHI, 2008)

## Wait times for CT and MRI exams

Comparison of wait times for imaging exams between jurisdictions remains problematical. CIHI notes that “Wide variation in reporting methods continues, making comparisons challenging. The methods for wait times reporting are not uniform and did not converge between December 2005 and December 2006. The variation in summary measures, time periods reported and time elapsed between data collection and reporting limits the potential for pan-Canadian comparisons and analysis.” (CIHI, 2007)

The CIHI comparison for five jurisdictions is shown below. All jurisdictions exclude emergency cases from these estimates.

### CT and MRI Scan Wait Times Reported by Provinces

	P.E.I.	N.S.	Ont.	Man.	Alta.
Wait segment	From booking to scan	From request to next day with three open appointments	From order to date exam completed	From booking to scan	From decision-to-treat to scan
Time frame	June – Dec, 2005	October 2006	Aug/ Sept, 2006	Sept 2006	Aug – Oct, 2006
Summary measure	Median	Number of days by facility	Median, mean, 90th percentile	Mean facility – specific maximum	Median
CT wait time	7 days (urgent) 70 days (routine)	Range: 2–65 days	13 days, 29 days, 79 days	77 days	9 days
MRI wait time	7 days (urgent) 105 days (routine)	Range 34–177 days	39 days, 50 days, 104 days	56 days	80 days

Source: CIHI, 2007

Estimates by the Fraser Institute, based on survey results, provide a further comparison:

**Median wait times for CT and MRI scans, 2006**

	CT scan, weeks	MRI scan, weeks
NL	5.0	28.0
PEI	9.0	13.0
NS	4.0	8.0
NB	5.0	9.0
Que	4.0	12.0
Ont	4.0	8.0
Man	6.0	10.0
Sask	5.0	12.0
Alta	4.0	9.0
BC	5.0	12.0
Canada	4.3	10.3

Source: Esmail, 2006

■ **INTERNATIONAL COMPARISONS**

This section includes data for Alberta and Canada given earlier in the report to provide some comparison but it should be noted that the years covered are usually different to those for the data from other countries.

**Scanners per population**

Numbers of CT scanners per million population for a number of countries are shown in the following tables. Most of the values from the OECD publication refer to 2005, but earlier sources were used for several countries. Data from the European Association of Radiology report are for 2003 or 2004.

The Alberta and Canadian values for numbers of CT scanners per population are lower than the OECD median.

## Number of CT scanners per million population\*

Country		
Japan	92.6	2002
Australia	45.3	
USA	32.2	2004; mobile CT scanners not included
S Korea	32.2	
Austria	29.4	
Belgium	29.0	EAR
Italy	27.7	
Greece	23.0	EAR
Switzerland	18.2	
Germany	15.4	Figure includes PET units
Finland	14.7	
[OECD median]	14.7	
Sweden	14.5	EAR
Denmark	13.8	
Spain	13.5	
Czech Republic	12.3	
New Zealand	12.1	
Canada	11.3	OECD, 2006
Singapore	10.5	Singapore Ministry of Health, 2007
Alberta	10.2	CIHI, 2006
Netherlands	10.0	EAR
France	9.8	
Poland	7.9	
UK	7.5	Private sector scanners not included
Eire	6.1	EAR

\* Data for 2005 unless otherwise noted

Source: OECD Health Data 2007 unless otherwise noted

EAR = European Association of Radiology survey, 2004

## MRI scanners

Numbers of MRI scanners per million population for several countries are shown below. As with the CT scanner information, the years to which the data refer are variable.

The Alberta total is above the OECD median, while that for Canada is below.

### Numbers of MRI scanners per million population \*

Country		
Japan	40.1	
USA	26.6	
Austria	16.3	
Italy	15.0	
Finland	14.7	
Switzerland	14.4	
S Korea	12.1	
Denmark	10.2	2004
Belgium	9.0	EAR
Spain	8.1	
Netherlands	8.0	EAR
Sweden	8.0	EAR
Alberta	7.8	CIHI, 2006
Germany	7.1	
[OECD median]	6.9	
Singapore	5.8	Singapore Ministry of Health, 2007
Canada	5.5	OECD, 2006
UK	5.4	Private sector not included
France	4.7	
Australia	3.7	RANZCR. Medicare approved units, 1999; (about 60% of total units)
Czech Republic	3.1	
Eire	2.0	
Poland	2.0	EAR

\* Data for 2005 unless otherwise noted

Source: OECD Health Data 2007 unless otherwise noted

EAR = European Association of Radiology survey, 2004

# Equipment age

The European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry (COCIR) has suggested the following guidelines for investment policies on medical equipment:

At least 60 % of the installed equipment base should be younger than 5 years; not more than 30 % should be between 6 - 10 years old; not more than 10% should be older than 10 years.

Age profiles published by COCIR for CT and MRI scanners in several countries are shown below.

Age of CT scanners, 2001

Country	% < 6y	% > 10y
France	69	2
UK	62	7
Sweden	63	12
Germany	57	7
Finland	60	17
Spain	55	16
Belgium	52	7
Netherlands	51	18
Italy	50	23
Mean	55	12
Alberta, 2007	76	0

Source: COCIR

## Age of MRI scanners, 2001

Country	% < 6y	% > 10y
Belgium	76	0
Germany	63	3
UK	61	2
France	58	7
Italy	58	11
Spain	57	11
Finland	56	3
Netherlands	53	4
Sweden	52	1
Mean	61	5
Alberta, 2007	33	5

Source: COCIR

Data for England in 2005 published by the Healthcare Commission indicate that 85% of CT scanners and 83% of MRI scanners were within the recommended life of 7 years.

## Frequency of use

CIHI found that numbers of exams per 1000 population for both CT and MRI were higher in the US than in Canada or in English public sector facilities.

MRI scanners are used more intensively in Canada than in the USA or than in public sector facilities in England. Data for Alberta compare favourably except for hours of operation per week for MRI scanners.

## Comparison of US, English and Canadian use of CT and MRI\*

	Exams per 1,000 population		Exams per scanner		Hours of operation per scanner per week	
	CT	MRI	CT	MRI	CT	MRI
USA (hospital sites)	207.4	88.9	6,108	3,460	58.0	69.1
England (public sector)	53.7	24.8	-	4,558	-	-
Canada	103.3	31.2	8,735	5,123	60	71
Alberta	108	41	10,502	5,616	65	65

\* Mean values

Source: CIHI, 2008

Information from the UK Healthcare Commission gives median values of 7829 exams per CT scanner and 3782 exams per MRI scanner for England in 2005. (Healthcare Commission, 2007)

The following table compares values for number of exams per 1000 population for Alberta and Canada with those of European countries. Rates for Alberta are higher than for most of the health systems for which data are available

**Number of exams per 1,000 population**

CT exams/1,000			MRI exams/1,000		
Belgium	138	CIHI 2008	Austria	59	
	120		Belgium	43	CIHI 2008
Greece	115		Alberta	40	CIHI 2006
Alberta	100	CIHI 2006	Sweden	39	CIHI 2008
Canada	87	CIHI 2006		12	
Austria	85		Switzerland	32	
Spain	57	CIHI 2008	Greece	29	
Czech Republic	50		Canada	26	CIHI 2006
Switzerland	50	CIHI 2008	Spain	21	CIHI 2008
Sweden	39		Denmark	17	CIHI 2008
	25			12	
Finland	38		Netherlands	11	
Denmark	35		Eire	8	
Eire	25		Finland	8	
Latvia	25		Czech Republic	7	
Netherlands	20		Poland	6	
Poland	16				

Source: EAR, 2004 unless otherwise indicated

A 2004 estimate for the USA was that there were 57 CT exams/1000 population annually and a 10% annual growth rate in the annual market for scanners. (Kala,2004) A 1997 report estimated there were 60 CT exams/1000 population in Australia. (Thomson & Tingey, 2007) The following table compares values for number of exams per 1000 population for Alberta and Canada with those of European countries. Rates for Alberta are higher than for most of the health systems for which data are available

The table below includes data on number of exams per scanner for several European countries. Numbers of exams per scanner are higher for Alberta and Canada than for any of the other countries except for MRI exams in Belgium.

#### Annual numbers of exams per scanner

Exams/CT scanner			Exams/MRI scanner		
Alberta	9,800	CIHI 2006	Belgium	5,740	CIHI 2008
Canada	7,745	CIHI 2006	Alberta	5,000	CIHI 2006
Greece	5,002		Canada	4,666	
Czech Republic	4,554		Eire	4,100	
Finland	4,204		Austria		
	3,693				
Belgium					
	4,810	CIHI 2008	Greece	3,608	
	4,132		Czech Republic	3,570	
Eire	4,100		Sweden	3,500	CIHI 2008
Poland	3,561			3,000	
Austria	2,929		Denmark	1,705	
Spain	2,690	CIHI 2008	Switzerland	1,500	
Sweden	2,448	CIHI 2008	Spain	1,498	CIHI 2008
Latvia	2,054		Netherlands	1,375	
Denmark	2,198		Finland	1,156	
Netherlands	2,000				
Sweden	1,718				

Source: EAR unless otherwise indicated

### Australian data

A survey in 1996 estimated that there were 3200 CT exams per scanner. (Thomson & Tingey, 1997)

A 2005 paper noted that 101 MRI scanners were eligible to provide services under Medicare arrangements. Overall average throughputs for these declined from 3657 in 2003/04 to 3475 in 2004/05. Annual unit throughputs ranged from less than 1000 to close to 10,000. Average throughputs were generally higher in the private sector (4002 in 2004/05) than in the public sector (2722 in 2004/05). (RANZCR, 2005)

## ■ WAIT TIMES

### **England**

A target waiting time limit of 13 weeks has been set for services provided by NHS Trusts in England. A report by the Healthcare Commission gave median wait times of 5.0 weeks for CT scans and 12.9 weeks for MRI exams for Autumn 2005. The report notes that recent monitoring data suggest that remarkable further progress was made during 2006 in eliminating waits that exceeded 13 weeks. (Healthcare Commission, 2007) Wait times for an imaging exam to be reported are given by the Commission as 2 days for Accident & Emergency, 4 days for inpatients and GP referrals, and 5 days for outpatients.

The Department of Health advised in February 2007 that the average wait for a non emergency patient was around 7.5 weeks for MRI scans and 2.5 weeks for CT scans. (UK Department of Health, 2007)

In February 2007 there were 58,589 persons waiting for CT exams, of whom 652 (0.6%) had been waiting more than 13 weeks. A total of 103,179 were waiting for MRI exams, 6249 of whom (6.1%) had been waiting more than 13 weeks. (UK Department of Health, 2007)

### **Scotland**

The target wait time for CT and MRI exams in NHS hospitals in Scotland is 9 weeks. During the last 6 months of 2006, 7.9% of persons waiting for a CT scan and 23.1% of persons waiting for an MRI scan had waited more than 9 weeks. (ISD Scotland, 2007)

### **European countries**

Thirteen of the 14 countries in the EAR survey indicated that there was immediate access to emergency imaging facilities for those requiring them.

In four countries there was immediate access to CT. In the others the average wait time was 3.6 weeks with a range of 1-14 weeks. In four countries there was immediate access to MRI. In the remaining countries the average wait time was 6.6 weeks with a range of 1-20 weeks. The data cover both public and private sector facilities. The definition of wait time is not included in the report.

Average wait times given in the EAR report for several European countries are shown below. The data are for 2003 and 2004. As noted previously, those for public sector services in England have since been considerably reduced.

**Wait time for CT exams**

Wait time, weeks	
Austria	< 1
Greece	< 1
Latvia	< 1
Switzerland	< 1
Belgium	1
Czech rep	1
France	2
Alberta 2007	3
Denmark	5
England and Wales	6
Sweden	10
Eire	14

**Wait times for MRI exams**

Wait time, weeks	
Belgium	< 1
Greece	< 1
Switzerland	< 1
Austria	2
Czech republic	4
Poland	4
Netherlands	7
France	8
Latvia	8
Denmark	9
Sweden	10
Alberta 2007	12
Eire	20
England & Wales	20

Source: EAR, 2004

## Other considerations

While CT and MRI services are an essential component of health care, their appropriate use is informed by safety considerations and by the extent to which they can be regarded as good value for money in a health care system.

### Patient safety

One of the risks from CT is the increased possibility of cancer induction from X-ray radiation exposure. (FDA, 2008) Use of CT involves larger radiation doses to the patient than conventional X-ray imaging procedures. For example, a CT head scan delivers 100 times the radiation dose from a chest X-ray and a CT abdominal scan 500 times as much. (FDA, 2008) Minimizing radiation exposure to children is an important consideration. (NCI, 2002)

The estimated individual risks from CT are small, but small individual risks applied to an increasingly large population may create a public health issue some years in the future. (Brenner & Hall, 2007) With increased use of CT, there has been an increase in average effective dose to hospital patients. CIHI notes as an example that at the Vancouver General Hospital, the average annual patient effective dose almost doubled between 1991 and 2002. (CIHI, 2008). In part, this would have been due to the higher radiation doses produced by newer types of CT scanner, which use higher X-ray tube currents than earlier machines.

Ideally, the minimum radiation dose should be used to provide the required diagnostic image quality. Surveys in British Columbia and Ontario have found significant variations between hospitals in CT radiation doses for the same type of exam. (CIHI, 2008).

It has been estimated from data on CT use from 1991 to 1996 that about 0.4% of all cancers in the US may be attributable to the radiation from CT studies. Adjusting for current CT use, this estimate might now be in the range of 1.5 to 2.0%. (Brenner & Hall, 2007)

Such risks have to be balanced by the substantial benefits associated with use of CT, including more effective patient management and avoidance of invasive procedures.

In the US, the largest increases in CT use have been in the categories of pediatric diagnosis and screening of asymptomatic adults. The major growth area in CT use for children has been presurgical diagnosis of appendicitis. Areas attracting the most interest in adult screening are colon cancer, lung cancer, cardiac disease, and CT whole body screening. Health benefits of such screening programs are not yet established.

It has been suggested that despite the fact that most diagnostic CT scans are associated with very favorable ratios of benefit to risk, there is a strong case to be made that too many CT studies are being performed in the US.

One measure to curb undue exposure to radiation is to ensure that CT is not used in situations where lower risk methods with similar effectiveness are available. Guidelines produced by professional bodies are helpful in indicating areas of appropriate use.

In addition to clinical issues, “a problem arises when CT scans are requested in the practice of defensive medicine, or when a CT scan, justified in itself, is repeated as the patient passes through the medical system, often simply because of a lack of communication.” (Brenner & Hall, 2007)

It has been suggested that three ways to reduce the overall radiation dose from CT in the population are to reduce the CT-related dose in individual patients, to replace CT use, when practical, with other options, and to decrease the number of CT studies that are prescribed. (Brenner & Hall, 2007)

MRI does not make use of ionizing radiation, but there are potential hazards from the interaction of the magnetic field with ferromagnetic objects in the patient or in the examination room. The risks are smaller with low-field strength scanners than with higher field strength systems. These risks are well understood and taken into account in routine practice.

Iodinated contrast media are widely used in CT. Risks from these material are well defined, with adverse effects from currently used material studied in large series of patients. (Mortelé, 2005) Significant adverse effects from gadolinium contrast media used in MRI exams are rare.

## **Value for money from CT and MRI services**

Value for money (VFM) in the context of this paper can be taken as the extent to which payers for CT and MRI have obtained the maximum benefit from these services, within the resources available. VFM covers the cost of goods and services, but also takes account of the mix of quality, cost, resource use; fitness for purpose; timeliness; and convenience. (Erlendsson, 2002)

### **Trends in expenditure**

In 2005 - 2006, Canadian hospitals reported an estimated \$2.2 billion for the operation of diagnostic imaging services. Hospital operating expenses for diagnostic imaging equipment included 17% for CT and 9% for MRI. (CIHI, 2008).

Distribution of these expenses included 61% for compensation, 22% for supplies, and 16% for equipment. The share of operational equipment expenses was the highest for MRI (24%); for CT this share was 17%. Corresponding proportions for compensation to health professionals were 68% and 73%, respectively.

MRI had the highest percentage increase in operating expenses of six types of imaging equipment between 2001 - 2002 and 2005 - 2006 (103%), followed by cardiac catheterization (94%) and CT (73%).

In the US, from 2000 through 2006, Medicare spending for imaging services paid for under the physician fee schedule more than doubled. CT scans, MRI, and nuclear medicine rose substantially faster than other imaging services. (GAO, 2008)

Reasons suggested for the growth in advanced imaging services for Medicare in the US include technological innovation, replacement of older invasive methods, patient demand influenced by direct-to-consumer advertising, defensive medicine, and an increase in clinical applications. Other suggested factors was the ability of physicians to refer patients to their own practices for imaging and lack of knowledge by primary care physicians about the most appropriate test to order for a patient, with a tendency to order a significant portion of imaging tests that would be considered unnecessary based on clinical guidelines. (GAO, 2008)

### **Elements of value for money for CT and MRI**

VFM of diagnostic imaging technologies can be considered in terms of different elements and at different levels of organization. Elements include operational aspects such as level of utilization, indications for use of diagnostic imaging, where the diagnostic imaging exam sits within the decision making pathway, effects on management decisions, and consequent effects on population health and health care budgets.

Assessing VFM of technologies such as CT and MRI is challenging. Their economic benefits are not readily quantified, in part because these may extend well beyond the immediate episode of investigation. The technologies are used in various ways in the management of a large number of diseases and conditions. Also, there is limited information available from economic studies.

Roles of CT and MRI include diagnosis (to confirm or rule out a disease or condition), treatment planning, staging/monitoring, screening, and guidance in interventional procedures. Factors that may need to be considered in assessing their VFM are listed in the following box.

**Factors to consider in assessing VFM of CT and MRI**

- Patient history, including previous diagnostic results
- Influence of CT/MRI on management decisions – likely probability and extent
- Procedures/interventions replaced through use of CT/MRI
- Procedures/interventions avoided through use of CT/MRI
- Need for/frequency of additional CT/MRI tests in a management episode
- Procedures/interventions undertaken as a result of CT/MRI
- Possible use of alternative, less expensive tests
- Decreased morbidity, mortality as a result of better information from CT/MRI
- Any adverse effects due to CT/MRI

**Operational considerations**

A consideration in the operation of expensive equipment such as CT and MRI scanners is whether they are being used at a reasonably high capacity. Data given earlier in this paper show that utilization of both CT and MRI at large institutions in Alberta is at a high level (112 and 93 hours per scanner per week, respectively). The average utilization for the province is much lower (57 and 62 hours per week), suggesting that some scanners could be used more frequently, with a reduction in the capital cost component of expenditure per imaging exam. However, increased utilization would be associated with higher staffing costs, which form a major proportion of overall expenditure on imaging services. Also, in smaller centres of population there may be insufficient numbers of persons with appropriate indications for CT or MRI exams to justify any increase in operational capacity. Under-utilization of some scanners may need to be seen as a trade-off for increasing the access of smaller communities to these imaging services.

Different types of CT and MRI scanners are available and use of lower-cost versions of the technologies might be considered as a contribution to obtaining VFM. In practice, the usefulness of such decisions will depend on the types of examinations that have to be performed and the extent to which lower cost

machines have less capability in some areas. For example, MRI scanners with lower magnetic field strength may provide lower image quality than high field strength scanners. Longer examination times can partially compensate for the difference in image quality, but longer times reduce patient throughput, and increase the likelihood of motion artifacts. High-field MRI scans are indicated for some central nervous system and vascular studies. If the studies are performed on a low-field scanner, they may have to be repeated on a high-field scanner. (CADTH, 2006)

### **Replacement or avoidance of other procedures**

Both CT and MRI have achieved savings to health systems through replacement of older diagnostic methods and avoidance of interventional procedures. Such savings provide an offset to the cost of CT and MRI, though the size of the offset may be limited.

An early Australian HTA estimated that replacement of older diagnostic procedures, such as X-ray exams and neuroangiography, by CT would provide annual savings to public health insurance (medical benefits) of about \$1 million with possibly an additional \$0.5 million savings in associated hospital costs. However, in comparison with these savings, there would be an increase of about \$59 million in health insurance payments for CT exams. Savings in public hospital from replacement of older procedures were possibly \$5 - 10 million per year. (NHTAP,1988).

With MRI, an Australian study showed overall savings for teaching hospitals in the diagnosis of seven neurological conditions for which MRI was known to be promising through eliminating more invasive alternative exams and associated need for hospitalization. A wider analysis suggested replacement by MRI of relevant services covered by national insurance would give net additional costs nationally of \$68 million. (Hailey, 1997)

### **Cost-effectiveness studies**

A Canadian HTA summarized available evidence from 2000 onwards on the cost-effectiveness of CT and MRI in investigating 13 clinical conditions identified by the Canadian Association of Radiologists as areas for which investigative use of the imaging technologies could be further explored. (Murtagh, 2006)

The HTA identified 22 economic evaluations addressing CT and MRI in the context of eight clinical conditions (peripheral vascular disease (PVD), renal artery stenosis, lung cancer screening, pulmonary embolism, head injuries, stroke, carotid artery disease, and cerebral aneurysm). There were no acceptable economic evaluations of CT or MRI in coronary artery disease, headaches, seizures, arteriovenous malformations, and urinary tract calculi screening.

Results of the evaluations suggested that CT and/or MRI are effective in some contexts (especially PVD and stroke) but not necessarily more effective or cost-effective than traditional alternatives (for PVD). In other contexts, evidence of cost-effectiveness appears positive but is limited (renal artery stenosis and head injuries). The evidence for effectiveness and/or cost-effectiveness of CT and/or MRI for lung cancer screening, pulmonary embolism, carotid artery disease, and cerebral aneurysm was considered to be equivocal or conflicting.

Information available from a Cost-Effectiveness Analysis Registry also indicates the limited number studies on CT and MRI that are available. (Tufts Medical Center, 2008) Review of studies in the registry also points to variety of roles for the technologies and that the analyses are generally applied to quite specific clinical situations and patient populations.

Of 15 studies on CT, six relate to its use in lung cancer (one of these studies was also included in the Canadian HTA). Two of the six studies are on screening, one on staging, one on follow up after resection, and two on management protocols in combination with PET. There are three studies on CT in other types of cancer, all in protocols with other diagnostic methods, two on injury, two on screening for coronary artery disease, and two on stroke. The studies on stroke and on cervical spinal trauma perhaps provide the most generally applicable indications of benefit from use of CT.

Nine of 18 studies on MRI deal with MR angiography. Five of these relate to carotid artery disease, with some support for protocols in combination with ultrasound examination. There is also support for MRA in PVD and progressive renal failure, but not in medicine-resistant hypertension or coronary artery disease.

The nine MRI studies include five on management of different types of cancer, two on back pain, and one each on neural tube defects and single episode neurological symptoms. The level of support for use of MRI varied considerably with the type of pathology and level of risk from the condition in question.

Overall, the available cost-effectiveness studies provide only limited insight into the VFM of CT and MRI in a small proportion of the clinical applications for which they are used. The Canadian HTA noted that most cost-effectiveness studies made no comment on the generalizability of their findings. Data from the cost-effectiveness studies typically reflect conditions applicable to a particular institution or jurisdiction. (Buskens et al., 2004 ) noted that trial-based estimates are generally better than those achieved in routine practice and suggested that cost-effectiveness will be driven in part by local considerations regarding diagnostic and treatment strategies.

## VFM from a health system perspective

It is difficult to judge the VFM of all the CT and MRI services undertaken within a jurisdiction, or to compare VFM between different jurisdictions. CIHI has commented that although medical imaging technologies have become essential tools in health care, there is little comparable information on the costs of providing these services across the country. (CIHI, 2008) Quantitative information on overall benefits from CT and MRI are not available. As noted previously, cost-effectiveness studies provide only an imperfect indication of VFM in a limited number of applications and may not relate to the reality of how CT and MRI are being used routinely.

In Alberta, prioritization guidelines have been developed by a joint committee (from Alberta Health & Wellness, the Alberta Society of Radiologists and Regional Health Authorities) to maximize the effective utilization of diagnostic imaging services. Measures to increase VFM of CT and MRI might start with continued development of guidelines for the appropriate use of these imaging services, updated as necessary to take account of significant new research findings.

Availability of such guidelines should be promoted and linked to measures that ensure their use by those requesting CT and MRI exams.

VFM could be improved by reducing the proportion of CT and MRI scans that are duplicated because of poor communication between different parts of the health system. Further implementation of appropriate information technology for health care providers would be helpful.

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This report presents summary information on computed tomography (CT) and magnetic resonance imaging (MRI) in Alberta, with comparison to the use of these diagnostic imaging technologies in other jurisdictions.

The aims of the report are to:

- illustrate the capacity in Alberta to diagnose and manage health problems with the help of these important technologies
- compare the numbers, age and utilization of CT and MRI scanners in Alberta, and the wait times for MRI and CT exams, with those in other health systems
- draw attention to issues related to the safety and value for money of CT and MRI services



INSTITUTE OF  
HEALTH ECONOMICS  
ALBERTA CANADA

Institute of Health Economics  
1200 - 10405 Jasper Avenue  
Edmonton AB Canada T5J 3N4

Tel. 780.448.4881 Fax. 780.448.0018  
info@ihe.ca

[www.ihe.ca](http://www.ihe.ca)

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