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ICES Institute for Clinical Evaluative Sciences

Utilization of CT and MRI Scanning Among Cancer Patients in Ontario, 1993–2002

ICES Investigative Report

December 2005

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Authors

Natalie Coburn, MD, MPH

Raymond Przybysz, MSc

Calvin Law, MD, MPH, FRCSC

Lisa Barbera, Bsc, MD, MPA, FRCPC

David Hodgson, MD, MPH, FRCPC

Sharon Sharir, MD, MPH, FRCSC

Andreas Laupacis, MD, MSC, FRCPC

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Institute for Clinical Evaluative Sciences (ICES)
G1 06, 2075 Bayview Avenue
Toronto, ON M4N 3M5
Telephone: 416-480-4055
www.ices.on.ca

Authors' Affiliations

Natalie G. Coburn, MD, MPH
Research Fellow, Institute for Clinical Evaluative Sciences
Surgical Oncology Fellow, University of Toronto

Raymond Przybysz, MSc
Research Coordinator, Institute for Clinical Evaluative Sciences

Calvin H.L. Law, MD, MPH, FRCSC
Hepatobiliary, Pancreatic and Gastrointestinal Surgical Oncology, Sunnybrook and Women's College Health Sciences Centre
Assistant Professor of Surgery, University of Toronto
Assistant Professor, Department of Health Policy, Management and Evaluation, University of Toronto
Associate Member, School of Graduate Studies, University of Toronto
Adjunct Scientist, Institute for Clinical Evaluative Sciences
Career Scientist, Ontario Ministry of Health and Long-Term Care

Lisa Barbera, BSc, MD, MPA, FRCPC
Radiation Oncologist, Sunnybrook and Women's College Health Sciences Centre
Assistant Professor, Department of Radiation Oncology, University of Toronto
Adjunct Scientist, Institute for Clinical Evaluative Sciences

David Hodgson MD, MPH, FRCPC
Assistant Professor, Departments of Radiation Oncology and
Health Policy, Management and Evaluation, University of Toronto
Adjunct Scientist, Institute for Clinical Evaluative Sciences

Sharon Sharir, MD, MPH, FRCSC
Urologic Oncologist, Divisions of Urology and Surgical Oncology, Sunnybrook and Women's College Health Sciences Centre
Assistant Professor, Department of Surgery, University of Toronto
Associate Scientist, Clinical Integrative Biology, Sunnybrook and Women's Research Institute

Andreas Laupacis, MD, MSC, FRCPC
President and CEO, and Senior Scientist, Institute for Clinical Evaluative Sciences
Professor, Departments of Health Policy, Management and Evaluation, and Faculty of Medicine, University of Toronto
General Internist, Sunnybrook and Women's College Health Sciences Centre

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Knowledge Transfer
Paula McColgan
Vice President, Policy and External Relations
Institute for Clinical Evaluative Sciences

Editor
Camille Marajh
Manager, Knowledge Transfer
Institute for Clinical Evaluative Sciences

Layout
Laura Benben
Senior Web and Graphic Designer
Institute for Clinical Evaluative Sciences

Shelley Drennan
Information Officer
Institute for Clinical Evaluative Sciences

About ICES

Ontario's resource for informed health care decision-making

ICES (Institute for Clinical Evaluative Sciences) is an independent, non-profit organization that conducts research on a broad range of topical issues to enhance the effectiveness of health care for Ontarians. Internationally recognized for its innovative use of population-based health information, ICES knowledge provides evidence to support health policy development and changes to the organization and delivery of health care services.

Unbiased ICES evidence provides fact-based measures of health system performance; a clearer understanding of the shifting health care needs of Ontarians; and, a stimulus for discussion of practical solutions to optimize scarce resources.

Key to ICES' research is our ability to link anonymous population-based health information on an individual patient basis, using unique encrypted identifiers that ensure privacy and confidentiality. This allows scientists to obtain a more comprehensive view of specific health care issues than would otherwise be possible. Linked databases reflecting 12 million of 30 million Canadians allow researchers to follow patient populations through diagnosis and treatment, and to evaluate outcomes.

ICES brings together the best and the brightest talent under one roof. Many of our faculty are not only internationally recognized leaders in their fields, but are also practicing clinicians who understand the grassroots of health care delivery, making ICES knowledge clinically-focused and useful in changing practice. Other team members have statistical training, epidemiological backgrounds, project management or communications expertise. The variety of skill sets and educational backgrounds ensures a multi-disciplinary approach to issues management and creates a real-world mosaic of perspectives that is vital to shaping Ontario's future health care.

ICES collaborates with experts from a diverse network of institutions, government agencies, professional organizations and patient groups to ensure research and policy relevance.

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Executive Summary

Issue

Reducing wait times for key health services is one of the Ontario Government's top priorities, and an important part of its strategy to transform the Province's health care system.

According to the Ontario Government, wait times are a symptom of a broader problem: the lack of consistent management of how patients get access to care. Ontario's Wait Time Strategy is designed to improve access to health care services and reduce the time that Ontarians wait for services in five priority areas by December 2006: cancer surgery; selected cardiac procedures; cataract surgery; hip and knee total joint replacements; and, Magnetic Resonance Imaging (MRI)/Computerized Tomography (CT) scans.

One of the first steps in determining appropriate wait times is to determine current health resource utilization rates across the Province, and the appropriateness of that utilization.

Study

The purpose of this study is to determine the utilization of CT and MRI resources by cancer patients in Ontario, during the period from 1993 to 2002.

Using Ontario Health Insurance Plan (OHIP) billing data, linked to the Ontario Cancer Registry (OCR), a body responsible for gathering, processing and storing all newly diagnosed cases of cancer, the rate of utilization of CT and MRI scans for cancer patients by body site and by each Local Health Integration Network (LHIN) was determined. ICES then examined the utilization of scans for the five most common types of cancer.

Key Findings

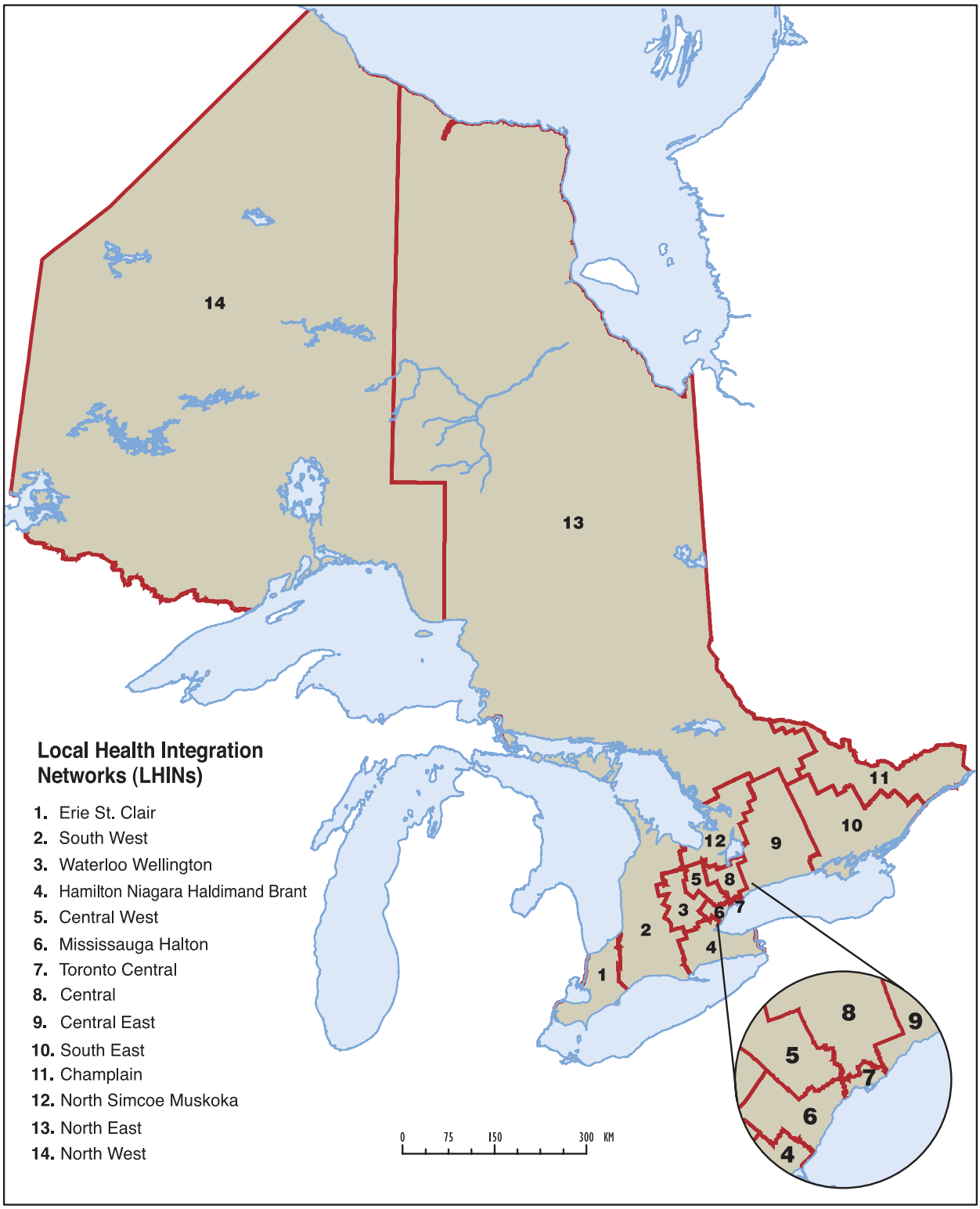
- The findings indicate that the use of CT scans in cancer patients has increased 2.3-fold over the nine-year period considered in the study, while MRI scans in cancer patients increased by 4.2-fold during the same period.
- The rate of CT and MRI for cancer patients increased at a lesser rate than that of CT and MRI scans in the general population.
- There was significant variation in the rate of utilization of CT and MRI when examined by the LHIN in which patients reside.
- When compared to the location of the scanner, there was even greater variation, suggesting that many patients are traveling outside of their LHIN for both imaging and cancer care.
- Further areas of examination raised include the possibility of under-/over-utilization of scanning at the disease-specific level.
- In general, the data suggest that there were appropriate rates of CT and MRI scans ordered for the top five cancers in Ontario as a whole.
- Cancer patients comprise a small percentage of the overall users of CT and MRI technologies in Ontario, which suggests that delays in their access to CT and MRI scans may be caused, at least in part, by the use of the equipment for other indications.
- A significant number of cancer patients travel outside of their LHIN for diagnostic imaging, which impacts decisions regarding resource allocation, including geographical location of equipment and utilization patterns.

Implications

Variations in CT and MRI utilization rates at the disease-specific and LHIN levels suggest the need to develop initiatives and approaches to improve compliance with existing imaging utilization guidelines for all cancer groups, and to develop new guidelines—an initiative currently being undertaken by Cancer Care Ontario (CCO). Evaluation of compliance could be undertaken by ICES, provided that data related to tumour size and staging of the cancer are available.

In addition, differences in utilization between LHINs and patient migration to different LHINs will need to be studied further. However, current patterns of travel to different LHINs for CT and MRI scans should be considered when planning the location of new CT and MRI scanners.

Local Health Integration Networks in Ontario, November 2005



Source: Ontario Ministry of Health and Long-Term Care

Introduction

As Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI) technologies have improved, indications for their use have expanded greatly. Multiple studies have shown an increase in the rates of CT and MRI for all indications over the past two decades.[1-3] However, few studies have been conducted to examine the rate of increase for specific indications of diagnostic imaging, such as oncology.

In Canada, special attention is being paid to the issue of wait times for health care services. Ontario has made wait times a priority, especially in the area of cancer surgery, by creating a publicly accessible website that identifies hospital-specific wait times. A population-based, Ontario study demonstrated that the median wait times for surgical intervention and treatment of breast, colorectal, lung and prostate cancer had significantly increased between 1993 and 2000.[4] However, this study did not describe the contribution of medical investigations to the overall wait times.

The wait time for a medical investigation or a surgery can be affected by the availability of a resource in a community or catchment area, such as a CT scanner, and the appropriateness and efficiency of its utilization. This report focuses on CT and MRI scanning in cancer patients to further delineate utilization trends within the context of expanding indications for imaging in cancer, and the importance of timely care in cancer patients.

The goals of this study were to:

1. Describe the change in utilization of imaging in oncology patients in Ontario over the period 1993–2002;
2. Analyze regional variations in utilization and availability of resources; and,
3. Examine site-specific utilization and its appropriateness.

Chapter 1—Overall Trends and Utilization

List of Exhibits

Exhibits—Findings

Exhibit 1.1 Number of cancer patients diagnosed* and registered in the Province of Ontario in 2002, by cancer type

Cancer Site	Cancer Patients Registered by the Ontario Cancer Registry in 2002
Prostate	7,550
Female breast	7,326
Colorectal	6,884
Lung	6,682
Lymphoma	2,690
non-Hodgkin's	*2,339*
Hodgkin's	*351*
Uterus	1,989
corpus	*1,450*
cervix	*499*
unspecified	*40*
Skin, melanoma	1,620
Bladder	1,598
Kidney	1,577
Leukemia	1,503
Thyroid gland	1,461
Oral cavity	1,048
Pancreas	1,044
Others**	8,918
TOTAL number of incident cancer cases	**51,890**

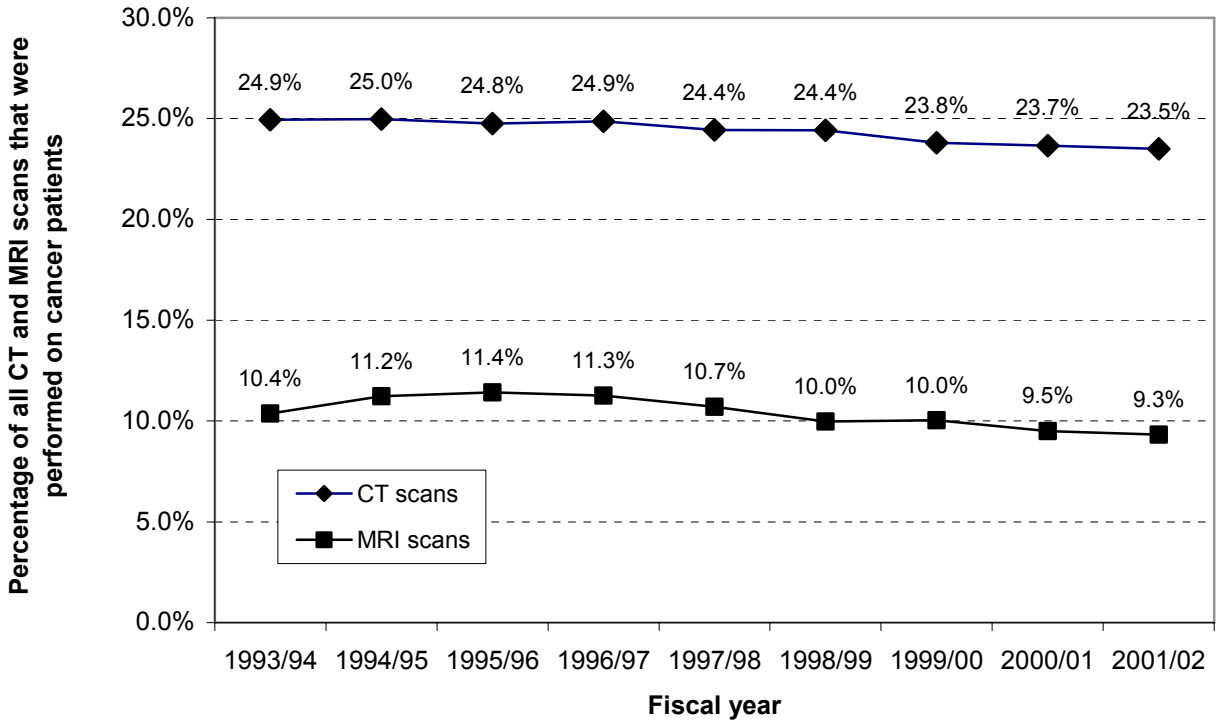
* Patients may have multiple primaries; all primaries were included.

** Sites with less than 1,000 patients registered in 2002 by OCR.

Data source: Cancer Care Ontario - Ontario Cancer Registry

- From 1993–2002, there were 468,033 primary tumours registered in the OCR.
- In 2002, the OCR registered 51,890 incident cancers of which prostate, female breast, colorectal, lung and lymphoma were the most common.

Exhibit 1.2 Percentage of inpatient/outpatient CT and outpatient MRI scans performed from three months before, and up to five years after diagnosis, among all Ontario cancer patients diagnosed* between 1988/89–2001/02



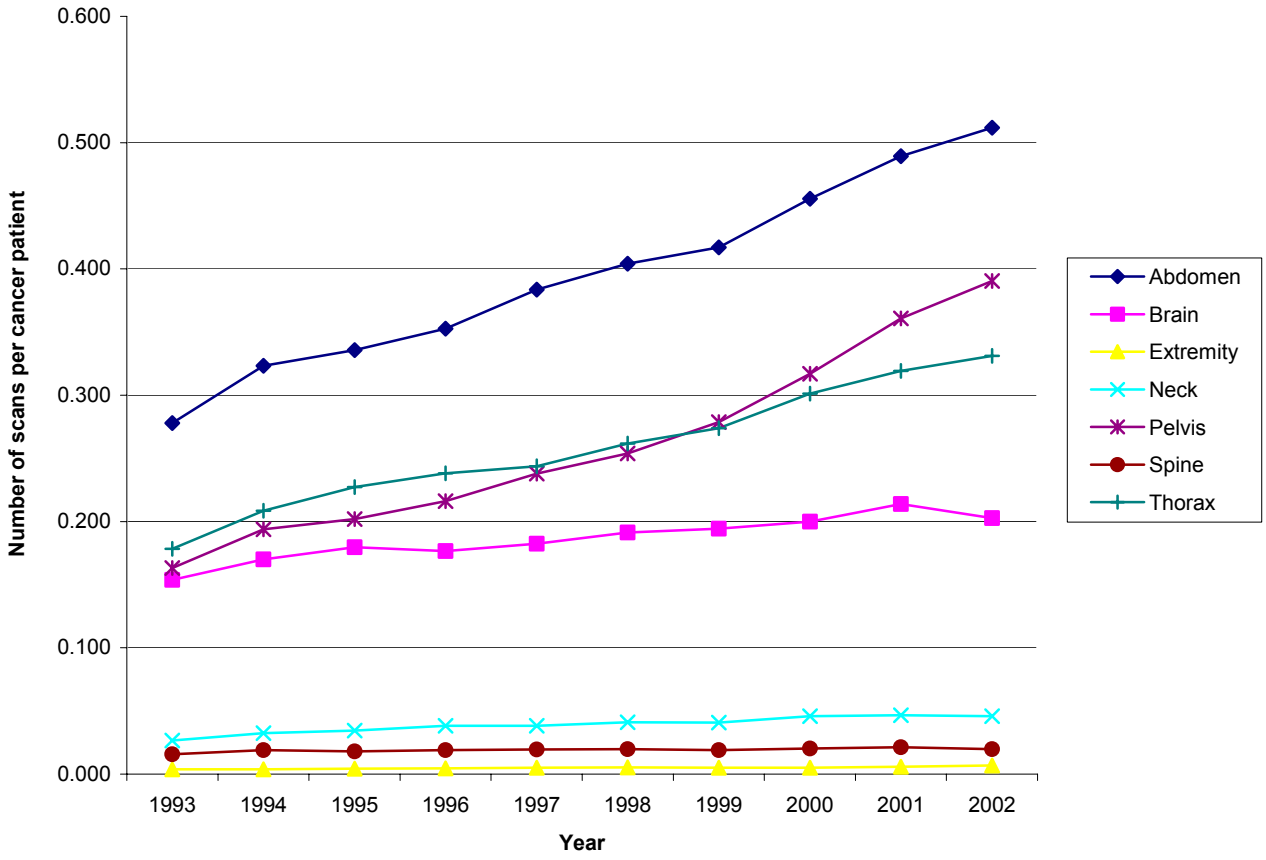
* Includes patients diagnosed between 1988/89–1992/93 to allow for a five-year follow-up; may include multiple scans per patient; data for 2002 cancer patients was incomplete and therefore not presented.

** Data from *Access to Health Services in Ontario: ICES Atlas*. Toronto: Institute for Clinical Evaluative Sciences; 2005

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- From 1993/04–2001/02, the rate of scans that occurred in patients with a diagnosis of cancer increased by 2.3-fold for CT scans and by 4.2-fold for MRI scans (data not shown).
- An earlier ICES study showed that the rate of CT scans for all indications in the entire population increased three-fold and the rate of MRI scans increased more than six-fold.[1]
- The number of scans performed on patients with a diagnosis of cancer as a percentage of all scans performed in that year is shown above. The proportion of scans that were performed on cancer patients decreased over the ten-year period, because the increase in the number of scans for the entire population was greater than the increase in the number of scans among cancer patients.
- Patients with a diagnosis of cancer between 1988/89 and 1992/93 were included; any scan that was performed on a patient with a cancer diagnosis that occurred in the preceding five years was considered to be a scan for a cancer indication.

Exhibit 1.3 Rate of inpatient/outpatient CT scans per patient, by body site, within six months peri-diagnosis, among all Ontario cancer patients diagnosed* between 1993–2002

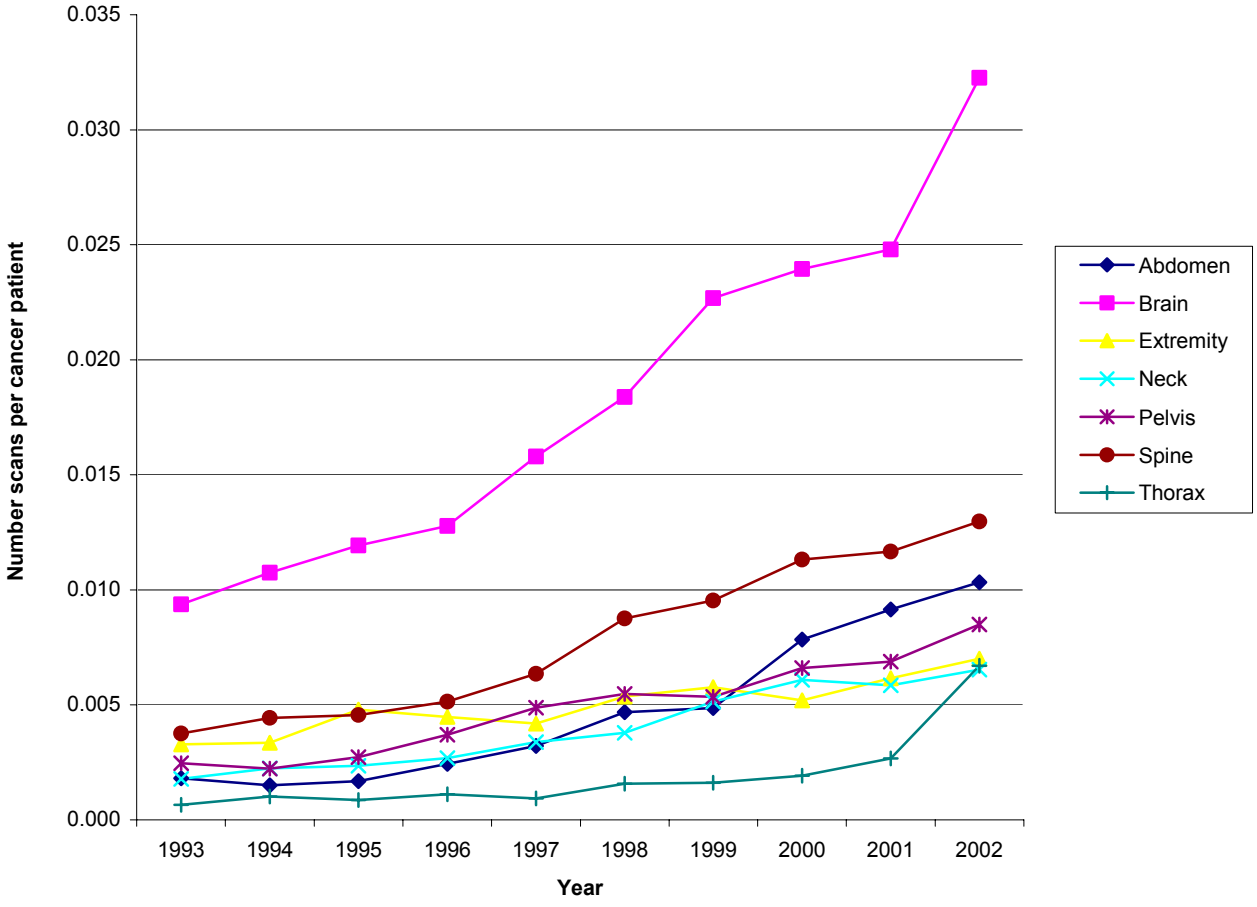


* Patients may have multiple primaries; all primaries were included.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- From 1993–2002, CT scans of the pelvis showed the highest rate of increase (2.4-fold). CT scans of the spine and brain showed the slowest rates of increase (1.3-fold). CT scan usage for abdominal, extremity, neck and thorax increased from 1.7-fold to 1.8-fold.

Exhibit 1.4 Rate of MRI scans per patient, by body site, within six months peri-diagnosis, among all Ontario cancer patients diagnosed* between 1993–2002



* Patients may have multiple primaries; all primaries were included.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- From 1993–2002, there was a 3.4-fold increase in the most common site of MRI, that being brain MRI. The remaining sites increased at the following rates: abdomen, 5.7-fold; extremity, 2.1-fold; pelvis, spine and neck, 3.4-fold to 3.7-fold; and thorax, ten-fold.
- The number of MRI scans per patient is approximately ten times fewer than the number of CT scans per patient.

Exhibit 1.5 Average number of inpatient/outpatient CT and outpatient MRI scan referrals* per physician, by specialty, within six months peri-diagnosis, among all Ontario cancer patients diagnosed in 2002**

	Inpatient/Outpatient CT Scan Referrals	Outpatient MRI Scan Referrals
General/Internal Medicine		
General Practitioner(GP)/ Family Practitioner(FP)	1.6	0.04
FP/Emergency Medicine	5.2	0.06
Internal Medicine	5.5	0.08
Emergency Medicine	5.8	0.06
Geriatric Medicine	6.1	0.06
Oncology/Hematology		
Medical Oncology	48.0	2.3
Hematology	37.0	1.3
Radiation Oncology	22.9	5.0
Other Medical Specialties		
Respirology	16.0	0.19
Gastroenterology	12.6	0.32
Neurology	2.8	1.4
General Surgery	19.1	0.61
Urology	23.7	0.72
Thoracic Surgery	70.1	5.2
Surgical Sub-specialties		
Otolaryngology	7.7	1.6
Obstetrics and Gynecology	2.0	0.22
Neurosurgery	23.7	4.2

* Only scans with valid referring physician identification (number, specialty) were included; may include multiple referring physicians per scan.

** Patients may have multiple primaries; all primaries were included.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan; Ontario Physician Human Resource Data Centre, Canadian Institute for Health Information, Ministry of Health and Long-Term Care, - Ontario Physician Master File

- The number of scans in cancer patients that were requested by physicians was measured by recording the ordering physician and consultant physicians. As expected, surgical and oncology sub-specialties have the highest rate of CT and MRI scan utilization in cancer patients. Sub-specialty data are shown only for rates >1.5 CT scan/physician and >0.04 MRI scan/physician.

Exhibit 1.6a Number and age- and sex-standardized* rates of inpatient/outpatient CT scans, within six months peri-diagnosis, per 1,000 Ontario cancer patients diagnosed in 2002, by Local Health Integration Network**

Local Health Integration Network	Based on Patient's Area of Residence				Based on Location of the Institution			
	Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank	Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank
1. Erie St. Clair	4,233	2,881	1,465.4	9	3,734	2,881	1,290.8	6
2. South West	5,976	4,387	1,363.4	13	6,681	4,387	1,529.1	4
3. Waterloo Wellington	3,825	2,537	1,503.1	8	3,250	2,537	1,286.2	8
4. Hamilton Niagara Haldimand Brant	8,414	6,148	1,374.2	12	7,852	6,148	1,287.2	7
5. Central West	3,245	2,023	1,599.5	4	2,426	2,023	1,271.7	10
6. Mississauga Halton	5,238	3,375	1,546.3	6	3,447	3,375	1,028.8	11
7. Toronto Central	8,893	4,974	1,803.6	1	19,901	4,974	4,044.4	1
8. Central	9,352	5,481	1,720.4	3	4,730	5,481	876.0	14
9. Central East	9,279	6,009	1,540.8	7	5,520	6,009	919.2	13
10. South East	3,528	2,423	1,457.6	10	3,422	2,423	1,412.7	5
11. Champlain	7,353	4,697	1,571.4	5	7,730	4,697	1,651.3	2
12. North Simcoe Muskoka	3,278	1,832	1,792.3	2	2,852	1,832	1,542.5	3
13. North East	4,691	3,208	1,451.7	11	4,155	3,208	1,280.1	9
14. North West	1,176	1,122	1,067.2	14	1,089	1,122	984.6	12
OVERALL	78,481	51,097	1,535.9	-	76,789	51,097	1,502.8	-
Extremal Quotient (EQ)	**1.7**				**4.6**			

* Standardized to the number of cancer primaries (more than one per patient possible) registered in 2002 in Ontario.

** Patients may have multiple primaries; all primaries were included.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan and Registered Persons Database; Statistics Canada - 2001 Census and Postal Code Conversion File

- Regional variation was examined according to the LHIN in which the patient resided to determine population utilization and access to care. For CT scans, there was a 1.7-fold variation between LHINs with the highest and lowest utilization rates in 2002. There was no change in variation over the years 2000–2002: in 2000 the variation was 1.7-fold and in 2001 it was 1.6-fold (data not shown).

- Also examined was the rate of scan per cancer patient, according to the location of the scanner, to study where the scans were performed and resource utilization. There was no change in the variation regarding the institution that performed the scans, with the EQ remaining constant at 4.6 for all three years (data not shown). A higher EQ and number of scans, based on the location of the scanner, show that patients are traveling outside the LHIN in which they reside to have testing performed.

Exhibit 1.6b Number and age- and sex-standardized* rates of outpatient MRI scans, within six months peri-diagnosis, per 1,000 Ontario cancer patients diagnosed in 2002, by Local Health Integration Network**

Local Health Integration Network		Based on Patient's Area of Residence				Based on Location of the Institution			
		Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank	Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank
1.	Erie St. Clair	116	2,881	41.0	14	68	2,881	23.9	11
2.	South West	263	4,387	62.3	12	335	4,387	79.4	4
3.	Waterloo Wellington	129	2,537	49.6	13	-	2,537	-	-
4.	Hamilton Niagara Haldimand Brant	442	6,148	75.8	9	443	6,148	75.9	5
5.	Central West	182	2,023	79.3	8	57	2,023	26.0	10
6.	Mississauga Halton	358	3,375	99.7	3	140	3,375	39.4	8
7.	Toronto Central	726	4,974	144.8	1	2,217	4,974	442.1	1
8.	Central	593	5,481	105.1	2	84	5,481	15.2	13
9.	Central East	514	6,009	85.0	7	140	6,009	23.2	12
10.	South East	210	2,423	90.5	6	208	2,423	89.2	3
11.	Champlain	445	4,697	96.4	4	472	4,697	102.6	2
12.	North Simcoe Muskoka	162	1,832	92.3	5	65	1,832	36.1	9
13.	North East	231	3,208	74.8	10	165	3,208	53.0	6
14.	North West	68	1,122	64.4	11	54	1,122	51.2	7
	OVERALL	4,439	51,097	86.9	-	4,448	51,097	87.1	-
	Extremal Quotient (EQ)	**3.5**				**29.1**			

* Standardized to the number of cancer primaries (more than one per patient possible) registered in 2002 in Ontario.

** Patients may have multiple primaries; all primaries were included.

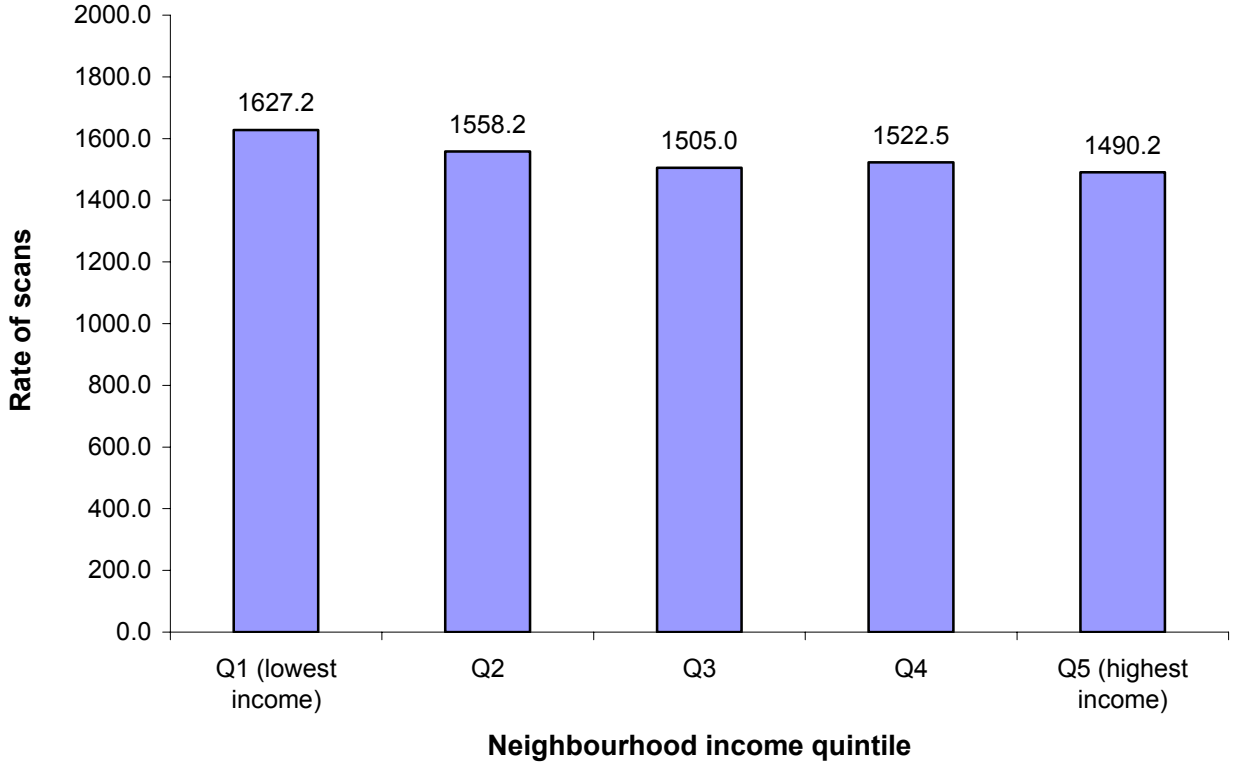
*** No MRIs were performed in the area of Waterloo Wellington for cancer patients in 2002.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan and Registered Persons Database; Statistics Canada - 2001 Census and Postal Code Conversion File

- For MRI, there was greater variation between the regions in which the most and fewest scans were performed than for CT scans. When examined by the patient's area of residence, the variation as expressed by the EQ increased from 2.8 in 2000, to 3.2 in 2001, and to 3.5 in 2002. When examined by the institution that performed the scan, the EQ decreased from 32.3 to 29.1, from 2000 to 2002 (data not shown).

- The extremely high EQ that appears for MRI by location of scanner shows that many patients are traveling to have MRI testing performed. While these EQs are higher than those seen with CT, the absolute difference in scans among regions is smaller because there are fewer MRI scans performed overall.

Exhibit 1.7a Age- and sex-standardized* rates of inpatient/outpatient CT scans, within six months peri-diagnosis, per 1,000 Ontario cancer patients diagnosed in 2002, by neighbourhood income quintile**

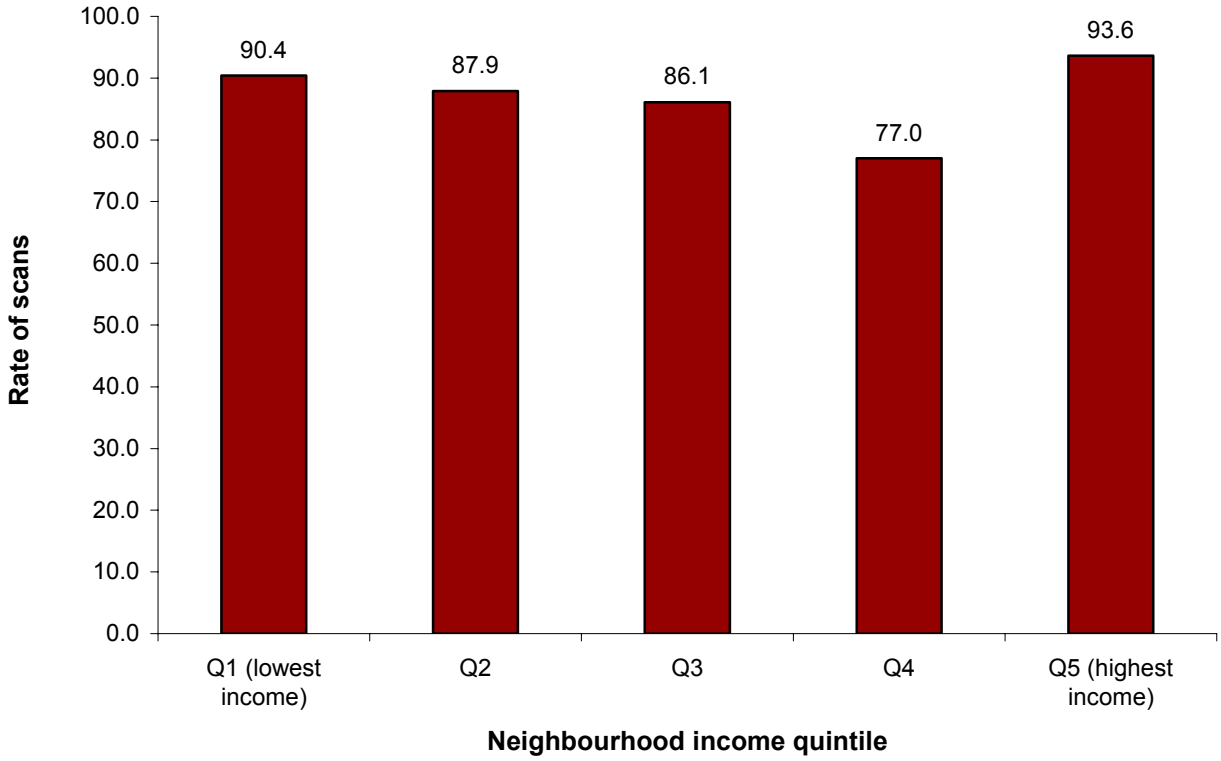


* Standardized to the number of cancer primaries (more than one per patient possible) registered in 2002 in Ontario.

**Patients may have multiple primaries; all primaries were included.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan and Registered Persons Database; Statistics Canada - 2001 Census and Postal Code Conversion File

Exhibit 1.7b Age- and sex-standardized* rates of outpatient MRI scans, within six months peri-diagnosis, per 1,000 Ontario cancer patients diagnosed in 2002, by neighbourhood income quintile**



* Standardized to the number of cancer primaries (more than one per patient possible) registered in 2002 in Ontario.
** Patients may have multiple primaries; all primaries were included.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan and Registered Persons Database; Statistics Canada - 2001 Census and Postal Code Conversion File

- Patients living in the poorest neighbourhoods were significantly more likely to receive a CT scan than those living in the wealthiest neighbourhoods, although the difference in rates is relatively small.
- For MRI scans, there is no clear relationship between neighbourhood income and rate of scanning.

Discussion

Overall utilization

In Ontario, from 1993 to 2002, there was a 2.3-fold increase in the number of Computerized Tomography (CT) scans that were ordered for cancer patients from three months prior to the date of diagnosis and up to five years following diagnosis. During approximately the same time period, there was a three-fold increase in the number of CT scans performed for all indications.

The rate of Magnetic Resonance Imaging (MRI) usage increased by 4.2-fold for cancer patients, while MRI scans increased six-fold for all indications.[1] Therefore, since the rate of imaging utilization for cancer did not rise as rapidly as it did for all indications, the proportion of scans performed in cancer patients decreased during the study period (Exhibit 1.2). For purposes of this study, a scan was considered to be performed for the indication of cancer surveillance if it occurred five years after the date of diagnosis. However, it is recognized that some scans were performed for unrelated indications, such as trauma.

The rates of overall increase in CT and MRI usage for all indications are similar to those found in studies in the United States (U.S.). Wittram et. al. found a 2.8-fold increase in CT usage for inpatients; a 4.1-fold increase in CT usage for emergency room patients; and, a 2.5 increase in CT usage per outpatient from 1996–2001 at the Massachusetts General Hospital.[2] Bhargavan and Sunshine found an 8% increase per year in the rate of CT scans in a convenience sampling (subset) of Medicare beneficiaries and MRI increased 10% per year between 1992 and 2001.[3] To our knowledge, there are no similar studies available that report the use of diagnostic imaging in cancer patients with which to compare our results.

Overall utilization by LHIN

When examined by Local Health Integration Network (LHIN), there was a relatively small variation between the regions with the highest rate of CT scans versus the LHIN with the lowest rate, for cancer patients. This rate was similar to the ratio of 1:6 that was found for CT utilization for all indications between 2001–2004.[1]

The ratio between highest and lowest utilization of MRI in cancer patients increased slightly over the last three years of the study: 2.7 in 2000; 2.8 in 2001; and 3.5 in 2002 (2000 and 2001 details not shown). Although MRI had higher ratios of regional variation than CT, fewer patients are affected by regional variation because MRI rates are ten-fold lower than CT rates.

Further studies are needed to determine the appropriate rate of utilization for CT and MRI scans. There may also be regional variation in the percentage of cancer patients who receive their MRI as an inpatient. Ontario Health Insurance Plan (OHIP) billing data do not include inpatient MRI; therefore, these unaccounted tests may explain part of the difference in MRI rates across the LHINs.

Many patients received their imaging studies in a LHIN other than the one where they lived. For example, over half of the scans that were performed in Toronto Central were for non-residents of that LHIN. This information should be taken into account when planning the location of new CT and MRI scanners. Further studies are necessary to determine which types of cancer patients are more likely to travel outside of their LHIN for cancer care.

The rate of utilization in 2002, based on the LHIN of the patient's residence, did not seem to be affected by the presence of a medical school (found in the South West, Hamilton Niagara Haldimand Brant, Toronto Central, South East and Champlain LHINs). However, when examining the LHINs that have the highest utilization rate based on the location of the scanners, there is migration into the LHINs with medical schools and tertiary care centres.

Rate of physician utilization

Higher physician utilization of scans for cancer patients was predictable based on physician specialty. Oncology and surgery sub-specialties were more likely to order scans than were general practitioners. In the peri-diagnostic setting, this finding is intuitive, since most patients are being intensively staged and initial treatment is being planned. Indications for scans were not available for imaging performed in the follow-up period. These data would help us to make conclusions regarding the appropriateness of follow-up investigations. Knowledge of the rates of utilization will be useful in assessing compliance with evidence-based guidelines for imaging.

Chapter 2—Site- and Disease-specific Utilization

Using Ontario Cancer Registry (OCR) files, it was determined that the most common cancers in 2002 were prostate, colorectal, female breast, lung and lymphoma. Patients with these five most common cancers, and only one primary cancer, were followed from 1998 to 2002 to assess the use of Computerized Tomography (CT), Magnetic Resonance Imaging (MRI) and ultrasound.

List of Exhibits

Exhibits—Findings

I. Breast cancer (female)

Exhibit 2.1a Number of inpatient/outpatient CT scans*, within six months peri-diagnosis, among Ontario breast cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	n	n/pt	n	n/pt	n	n/pt
Abdomen	329	0.053	419	0.065	447	0.071	511	0.078	591	0.085
Brain	280	0.046	293	0.045	285	0.045	381	0.058	318	0.046
Extremities	15	0.002	22	0.003	18	0.003	21	0.003	32	0.005
Neck	16	0.003	14	0.002	23	0.004	31	0.005	26	0.004
Pelvis	112	0.018	213	0.033	236	0.037	315	0.048	407	0.059
Spine	80	0.013	105	0.016	82	0.013	88	0.013	90	0.013
Thorax	211	0.034	270	0.042	312	0.049	360	0.055	384	0.055
Total	1,043	0.170	1,336	0.207	1,403	0.221	1,707	0.260	1,848	0.267

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 32,428

***n/pt = Number of scans per patient's primary

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

Exhibit 2.1b Number of outpatient MRI scans*, within six months peri-diagnosis, among Ontario breast cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	n	n/pt	n	n/pt	n	n/pt
Abdomen	6	0.001	11	0.002	17	0.003	27	0.004	32	0.005
Brain	15	0.002	19	0.003	30	0.005	36	0.005	45	0.006
Extremities	7	0.001	9	0.001	11	0.002	16	0.002	16	0.002
Neck	sp****	sp	sp	sp	sp	sp	sp	sp	sp	sp
Pelvis	9	0.001	11	0.002	7	0.001	6	0.001	7	0.001
Spine	29	0.005	38	0.006	56	0.009	46	0.007	48	0.007
Thorax	9	0.001	15	0.002	21	0.003	61	0.009	219	0.032
Total	78	0.013	103	0.016	143	0.023	194	0.030	368	0.053

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 32,428

***n/pt = Number of scans per patient with cancer

****sp = Cells with counts of five or less were suppressed to protect patient confidentiality

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- From 1998–2002, there was an increase in the rate of CT scans in breast cancer patients for abdominal, extremity, pelvic and thorax scans. For the other types of CT scans, there was no significant change over the five-year period.

- From 1998–2002, there was a significant increase in the rate of MRI scans in breast cancer patients for abdominal, brain and thorax scans. Thorax MRI scans showed the greatest rate of increase. During this time period, there were several studies ongoing in the Province regarding the utility of breast MRI, which is billed under the code of thorax MRI. For technical reasons, each breast must be scanned on different days. Therefore, the 219 scans performed in 2002 actually reflect 191 patients. For the other types of MRI scans, there was no significant change over the five-year period.

Exhibit 2.2 Number and age- and sex-standardized* rates of inpatient/outpatient CT scans and outpatient MRI scans, within six months peri-diagnosis, per 1,000 Ontario breast cancer patients diagnosed in 2002, by Local Health Integration Network**

Local Health Integration Network		CT Scans Based on Patient's Residence				MRI Scans Based on Patient's Residence			
		Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank	Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank
1.	Erie St. Clair	67	331	211.9	12	sp***	331	sp	14
2.	South West	170	567	294.0	6	26	567	46.6	7
3.	Waterloo Wellington	95	370	253.4	9	sp	370	sp	13
4.	Hamilton Niagara Haldimand Brant	138	787	176.7	14	31	787	42.3	8
5.	Central West	96	299	388.7	2	16	299	51.1	5
6.	Mississauga Halton	111	471	241.2	10	19	471	38.9	9
7.	Toronto Central	215	717	301.5	5	112	717	155.1	1
8.	Central	301	790	381.3	3	70	790	86.4	2
9.	Central East	212	740	282.4	7	36	740	48.3	6
10.	South East	90	306	313.4	4	6	306	18.3	12
11.	Champlain	125	677	183.4	13	38	677	55.9	4
12.	North Simcoe Muskoka	119	216	563.1	1	13	216	63.7	3
13.	North East	101	393	258.8	8	12	393	32.9	10
14.	North West	35	154	228.4	11	sp	154	sp	11
	OVERALL	1,875	6,818	275.0	-	386	6,818	56.6	-
	Extremal Quotient (EQ)	**3.2**				**50.0**			

* Standardized to the number of cancer primaries (more than one per patient possible) registered in 2002 in Ontario.

** May include multiple scans per patient (same or different body parts).

***sp = Cells with counts of five or less were suppressed to protect patient confidentiality

n = Total number of scans = 32,428

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan and Registered Persons Database; Statistics Canada - 2001 Census and Postal Code Conversion File

- When comparing the rate of CT scans performed in breast cancer patients by LHIN, there was a 3.2-fold difference between the rate of scans in the LHIN with the highest rate versus the rate of scans in the LHIN with the lowest rate.

- The difference in rate of MRI scans between the LHIN with the highest rate and the LHIN with the lowest rate was 50-fold. In the five-year period studied, there were many trials regarding breast MRI being conducted in the Toronto Central LHIN, which might explain, in part, the difference in MRI rates.

Exhibit 2.3 Number of inpatient/outpatient CT scans, outpatient MRI, and outpatient liver ultrasound scans* from three months before and up to three years after the date of diagnosis, among Ontario breast cancer patients diagnosed between 1998–2002

Any CT/MRI/Abdominal Ultrasound Scan**	Number of Patients		Number of Scans	
	n	Percentage		
6 months peri-diagnosis (91 days before and up to 91 days after the date of diagnosis)				
No scan	12,324	38.1%	CT	7,507
1 scan	15,517	47.9%	MRI	919
2+ scans	4,531	14.0%	Abdominal ultrasound	19,272
4 to 12 months (92–365 days) after the date of diagnosis				
No scan	22,107	70.7%	CT	8,534
1 scan	5,643	18.0%	MRI	1,203
2+ scans	3,517	11.2%	Abdominal ultrasound	6,909
Between 1 and 2 years (366–730 days) after the date of diagnosis				
No scan	20,601	68.3%	CT	11,180
1 scan	5,229	17.3%	MRI	1,981
2+ scans	4,323	14.3%	Abdominal ultrasound	7,579
Between 2 and 3 years* (731–1,095 days) after the date of diagnosis**				
No scan	20,188	69.9%	CT	11,067
1 scan	4,687	16.2%	MRI	2,148
2+ scans	3,994	13.8%	Abdominal ultrasound	6,764

* May include multiple scans per patient (same or different body parts).

** Calculated only for patients who were alive at the mid-point of follow-up period; patients registered by OCR based on their death certificate were excluded.

*** Some follow-up data may be missing for patients diagnosed in 2002.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- Within the six-month peri-diagnosis period, 38.1% of patients had no CT, MRI or abdominal ultrasound scan performed. In the treatment and follow-up time periods (four months to three years), more than two-thirds of patients had no scans performed. Of those who were scanned in the follow-up period, over half received CT scans.

II. Colorectal cancer

Exhibit 2.4a Number of inpatient/outpatient CT scans*, within six months peri-diagnosis, among Ontario colorectal cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	n	n/pt	n	n/pt	n	n/pt
Abdomen	2,492	0.441	2,887	0.495	3,624	0.594	4,246	0.677	4,793	0.769
Brain	376	0.066	441	0.076	437	0.072	474	0.076	530	0.085
Extremities	sp****	sp	13	0.002	10	0.002	19	0.003	31	0.005
Neck	8	0.001	9	0.002	14	0.002	10	0.002	17	0.003
Pelvis	2,171	0.384	2,545	0.437	3,280	0.537	3,969	0.633	4,511	0.723
Spine	34	0.006	32	0.005	44	0.007	45	0.007	47	0.008
Thorax	309	0.055	458	0.079	604	0.099	741	0.118	876	0.140
Total	5,395	0.954	6,385	1.095	8013	1.313	9,504	1.516	10,805	1.733

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 30,095

***n/pt = Number of scans per patient's primary

****sp = Cells with counts of five or less were suppressed to protect patient confidentiality

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

Exhibit 2.4b Number of outpatient MRI scans*, within six months peri-diagnosis, among Ontario colorectal cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	n	n/pt	n	n/pt	n	n/pt
Abdomen	21	0.004	21	0.004	36	0.006	42	0.007	58	0.009
Brain	sp****	sp	15	0.003	18	0.003	20	0.003	23	0.004
Extremities	sp	sp	sp	sp	sp	sp	sp	sp	sp	sp
Neck	sp	sp	sp	sp	sp	sp	sp	sp	sp	sp
Pelvis	16	0.003	22	0.004	51	0.008	57	0.009	74	0.012
Spine	11	0.002	11	0.002	9	0.001	13	0.002	26	0.004
Thorax	sp	Sp	sp	sp	sp	sp	sp	sp	sp	sp
Total	55	0.010	73	0.013	119	0.019	139	0.022	190	0.030

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 30,095

***n/pt = Number of scans per patient's primary

****sp = Cells with counts of five or less were suppressed to protect patient confidentiality

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- From 1998–2002, there were significant increases in the numbers of CT scans performed for the abdomen, brain, extremities, pelvis and thorax. For MRI scans, significant increases occurred in abdominal, brain, pelvis and spine scans, but not for the extremity, neck or thorax body site. Moreover, the frequency of MRI scanning in 2002 remained very low.

Exhibit 2.5 Number and age- and sex-standardized* rates of inpatient/outpatient CT scans and outpatient MRI scans, six months peri-diagnosis, per 1,000 Ontario colorectal cancer patients diagnosed in 2002, by Local Health Integration Network**

Local Health Integration Network		CT Scans Based on Patient's Residence				MRI Scans Based on Patient's Residence			
		Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank	Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank
1.	Erie St. Clair	532	347	1,520.0	11	sp***	347	sp	13
2.	South West	789	567	1,416.5	12	14	567	25.7	7
3.	Waterloo Wellington	490	288	1,674.0	7	sp	288	sp	14
4.	Hamilton Niagara Haldimand Brant	1,193	740	1,631.1	9	15	740	19.5	11
5.	Central West	455	221	2,011.9	3	sp	221	sp	9
6.	Mississauga Halton	758	384	1,942.5	5	20	384	47.4	5
7.	Toronto Central	1,354	545	2,521.0	1	9	545	16.7	12
8.	Central	1,417	655	2,150.4	2	25	655	38.5	6
9.	Central East	1,222	748	1,655.2	8	14	748	19.7	9
10.	South East	397	268	1,528.4	10	6	268	23.6	8
11.	Champlain	1,007	595	1,698.6	6	30	595	50.3	3
12.	North Simcoe Muskoka	438	216	1,985.9	4	11	216	53.3	1
13.	North East	519	423	1,235.5	13	20	423	48.0	4
14.	North West	103	139	726.7	14	8	139	53.0	2
	OVERALL	10,674	6,136	1,739.6	-	186	6,136	30.3	-
	Extremal Quotient (EQ)	**3.5**				**5.1**			

* Standardized to the number of cancer primaries (more than one per patient possible) registered in 2002 in Ontario.

** May include multiple scans per patient (same or different body parts).

***sp = Cells with counts of five or less were suppressed to protect patient confidentiality

n = Total number of scans = 30,095

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan and Registered Persons Database; Statistics Canada - 2001 Census and Postal Code Conversion File

- There was a 3.5-fold difference in the rate of CT scans performed in colorectal cancer patients when comparing the LHIN with the highest rate to the LHIN with the lowest rate.

- For MRI scans, there was a 5.1-fold difference in the rate of scans between the LHIN with the highest rate and the LHIN with the lowest rate.

Exhibit 2.6 Number of inpatient/outpatient CT scans, outpatient MRI and abdominal ultrasound scans* from three months before and up to three years after the date of diagnosis, among Ontario colorectal cancer patients diagnosed between 1998–2002

Any CT/MRI/Abdominal Ultrasound Scan**	Number of Patients		Number of Scans	
	n	Percentage		
6 months peri-diagnosis (91 days before and up to 91 days after the date of diagnosis)				
No scan	7,335	24.5%	CT	40,748
1 scan	7,343	24.5%	MRI	592
2+ scans	15,311	51.1%	Abdominal ultrasound	16,295
4 to 12 months (92–365 days) after the date of diagnosis				
No scan	11,130	45.2%	CT	30,475
1 scan	4,274	17.3%	MRI	867
2+ scans	9,235	37.5%	Abdominal ultrasound	9,990
Between 1 and 2 years (366–730 days) after the date of diagnosis				
No scan	9,428	43.8%	CT	31,130
1 scan	3,666	17.0%	MRI	965
2+ scans	8,445	39.2%	Abdominal ultrasound	9,991
Between 2 and 3 years* (731–1,095 days) after the date of diagnosis**				
No scan	9,519	49.7%	CT	23,688
1 scan	3,289	17.2%	MRI	805
2+ scans	6,341	33.1%	Abdominal ultrasound	7,158

* May include multiple scans per patient (same or different body parts).

** Calculated only for patients who were alive at the mid-point of follow-up period; patients registered by OCR based on their death certificate were excluded.

*** Some follow-up data may be missing for patients diagnosed in 2002.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- From 1998–2002, 24.5% of patients had no CT, MRI or abdominal ultrasound for the staging and diagnosis of their colorectal cancer in the six-month peri-diagnosis period. During the treatment and follow-up time periods, over 40% of colorectal patients received no scans.

Exhibit 2.7 Number of repeated inpatient/outpatient CT, outpatient MRI and liver ultrasound scans* for abdomen and pelvis within four weeks of each other (1–28 days), among Ontario colorectal cancer patients diagnosed between 1998–2002

	Abdomen		Pelvis	
	CT	CT/MRI/Abdomen Ultrasound	CT	CT/MRI
Within 3 months (± 91 days) of the date of diagnosis				
Scans	18,329	34,805	16,742	16,971
Patients**	14,098	21,889	13,022	13,082
1 scan only	11,152	13,160	10,441	10,379
2+ scans	2,946	8,729	2,581	2,703
At least 1 repeat within 4 weeks anywhere	1,385	4,695	1,256	1,336
At least 1 repeat within 4 weeks in the same hospital***	1,173	2,472	1,067	1,115
4 to 12 months (92–365 days) after the date of diagnosis				
Scans	13,320	23,600	11,998	12,230
Patients**	7,906	12,617	7,391	7,431
1 scan only	4,669	6,609	4,562	4,525
2+ scans	3,237	6,008	2,829	2,906
At least 1 repeat within 4 weeks anywhere	400	1,541	361	420
At least 1 repeat within 4 weeks in the same hospital***	295	965	271	317
1 to 2 years (366–730 days) after the date of diagnosis				
Scans	13,070	23,346	11,917	12,171
Patients**	6,972	11,299	6,534	6,566
1 scan only	3,710	5,436	3,558	3,540
2+ scans	3,262	5,863	2,976	3,026
At least 1 repeat within 4 weeks anywhere	297	1,303	270	324
At least 1 repeat within 4 weeks in the same hospital***	196	734	187	223

* May include multiple scans per patient (same or different body parts); same day CT/MRI/liver ultrasound scans were not considered to be repeats.

** Calculated only for patients who were alive at the mid-point of follow-up period; patients registered by OCR based on their death certificate were excluded.

*** Determined only for patients with valid institutions.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- When examining CT scans for colorectal cancer patients in the six-month peri-diagnosis time period, nearly 10% of patients had repeat scans within four weeks of each other (1,385/14,098 for abdominal and 1,256/13,022 for pelvic CT scan). A significant proportion of these were performed at the same institution.

- When all types of abdominal scans are examined, there is a larger percentage of two scans occurring within a four-week period: 21.4% (4,695/21,889). In the follow-up time period (four months to two years), there are fewer repeat scans.

III. Lung cancer

Exhibit 2.8a Number of inpatient/outpatient CT scans*, within six months peri-diagnosis, among Ontario lung cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	n	n/pt	n	n/pt	n	n/pt
Abdomen	3,082	0.503	3,125	0.512	3,621	0.579	3,789	0.597	3,893	0.636
Brain	2,596	0.424	2,815	0.461	3,016	0.482	3,356	0.528	3,242	0.530
Extremities	37	0.006	41	0.007	36	0.006	58	0.009	90	0.015
Neck	117	0.019	124	0.020	156	0.025	178	0.028	152	0.025
Pelvis	555	0.091	664	0.109	954	0.153	1,196	0.188	1,450	0.237
Spine	219	0.036	232	0.038	260	0.042	257	0.040	227	0.037
Thorax	5,841	0.954	6,211	1.018	6,911	1.106	7,284	1.147	7,053	1.153
Total	12,447	2.032	13,212	2.165	14,954	2.392	16,118	2.537	16,107	2.632

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 30,948

***n/pt = Number of scans per patient's primary

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

Exhibit 2.8b Number of outpatient MRI scans*, within six months peri-diagnosis, among Ontario lung cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	n	n/pt	n	n/pt	n	n/pt
Abdomen	28	0.005	20	0.003	25	0.004	49	0.008	56	0.009
Brain	88	0.014	111	0.018	123	0.020	164	0.026	387	0.063
Extremities	6	0.001	6	0.001	11	0.002	14	0.002	24	0.004
Neck	sp****	sp	sp	sp	sp	sp	sp	sp	sp	sp
Pelvis	sp	sp	sp	sp	6	0.001	sp	sp	10	0.002
Spine	82	0.013	100	0.016	134	0.021	125	0.020	143	0.023
Thorax	28	0.005	22	0.004	25	0.004	32	0.005	40	0.007
Total	238	0.039	266	0.044	329	0.053	393	0.062	665	0.109

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 30,948

***n/pt = Number of scans per patient's primary

****sp = Cells with counts of five or less were suppressed to protect patient confidentiality

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- From 1998–2002, there were significant increases in the numbers of CT scans performed for all body sites except for spine.
- For MRI scans, significant increases occurred in abdominal, brain, extremity and spine scans, but not for the thorax, neck or pelvis body sites.

Exhibit 2.9 Number and age- and sex-standardized* rates of inpatient/outpatient CT scans and outpatient MRI scans, six months peri-diagnosis, per 1,000 Ontario lung cancer patients diagnosed in 2002, by Local Health Integration Network**

Local Health Integration Network		CT Scans Based on Patient's Residence				MRI Scans Based on Patient's Residence			
		Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank	Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank
1.	Erie St. Clair	944	357	2,614.3	9	13	357	33.3	14
2.	South West	1,327	503	2,617.4	8	44	503	84.2	10
3.	Waterloo Wellington	741	284	2,564.6	11	17	284	54.8	13
4.	Hamilton Niagara Haldimand Brant	1,547	739	2,099.1	13	84	739	119.4	4
5.	Central West	514	181	2,775.3	6	33	181	164.1	2
6.	Mississauga Halton	936	322	2,892.4	5	28	322	88.1	9
7.	Toronto Central	1,722	571	3,063.8	3	134	571	241.3	1
8.	Central	1,626	537	3,075.4	2	73	537	142.6	3
9.	Central East	1,872	669	2,771.0	7	70	669	103.2	7
10.	South East	822	340	2,356.3	12	32	340	89.4	8
11.	Champlain	1,867	643	2,902.1	4	74	643	110.4	5
12.	North Simcoe Muskoka	802	263	3,089.8	1	27	263	107.9	6
13.	North East	1,170	452	2,570.4	10	27	452	61.3	12
14.	North West	264	139	1,797.9	14	10	139	72.7	11
	OVERALL	16,154	6,000	2,692.3	-	666	6,000	111.0	-
	Extremal Quotient (EQ)	**1.7**				**7.2**			

* Standardized to the number of cancer primaries (more than one per patient possible) registered in 2002 in Ontario.

** May include multiple scans per patient (same or different body parts).

n = Total number of scans = 30,948

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan and Registered Persons Database; Statistics Canada - 2001 Census and Postal Code Conversion File

- There was a 1.7-fold difference in the rate of CT scans performed in lung cancer patients when comparing the LHIN with the highest rate to the LHIN with the lowest rate.
- For MRI scans there was a 7.2-fold difference between the LHIN with the highest rate and the LHIN lowest rate.

Exhibit 2.10 Number of inpatient/outpatient CT scans, outpatient MRI and liver ultrasound scans* from three months before and up to three years after the date of diagnosis, among Ontario lung cancer patients diagnosed between 1998–2002

Any CT/MRI/Abdominal Ultrasound Scan**	Number of Patients		Number of Scans	
	n	Percentage		
6 months peri-diagnosis (91 days before and up to 91 days after the date of diagnosis)				
No scan	2,812	9.2%	CT	73,590
1 scan	5,039	16.4%	MRI	1,948
2+ scans	22,806	74.4%	Abdominal ultrasound	9,437
4 to 12 months (92–365 days) after the date of diagnosis				
No scan	5,422	36.2%	CT	28,547
1 scan	2,432	16.2%	MRI	1,412
2+ scans	7,123	47.6%	Abdominal ultrasound	3,403
Between 1 and 2 years (366–730 days) after the date of diagnosis				
No scan	3,864	43.7%	CT	15,019
1 scan	1,317	14.9%	MRI	893
2+ scans	3,662	41.4%	Abdominal ultrasound	2,048
Between 2 and 3 years* (731–1,095 days) after the date of diagnosis**				
No scan	3,423	52.3%	CT	8,554
1 scan	946	14.5%	MRI	500
2+ scans	2,176	33.2%	Abdominal ultrasound	1,279

* May include multiple scans per patient (same or different body parts).

** Calculated only for patients who were alive at the mid-point of follow-up period; patients registered by OCR based on their death certificate were excluded.

*** Some follow-up data may be missing for patients diagnosed in 2002.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- CT scans comprise the majority of diagnostic imaging tests performed for lung cancer. Only 9.2% of patients had no imaging performed in the six-month peri-diagnosis period. Follow-up scans occurred in less than 50% of patients from two-three years after diagnosis.

Exhibit 2.11 Number of repeated inpatient/outpatient CT scans* for thorax, within four weeks of each other (1–28 days), among Ontario lung cancer patients diagnosed between 1998–2002

	Thorax CT
Within 3 months (± 91 days) of the date of diagnosis	
Scans	33,609
Patients**	25,733
1 scan only	19,243
2+ scans	6,490
At least 1 repeat within 4 weeks anywhere	2,056
At least 1 repeat within 4 weeks in the same hospital***	1,516
4 to 12 months (92–365 days) after the date of diagnosis	
Scans	11,958
Patients**	6,942
1 scan only	3,705
2+ scans	3,237
At least 1 repeat within 4 weeks anywhere	287
At least 1 repeat within 4 weeks in the same hospital***	214
1 to 2 years (366–730 days) after the date of diagnosis	
Scans	6,233
Patients**	3,471
1 scan only	1,854
2+ scans	1,617
At least 1 repeat within 4 weeks anywhere	116
At least 1 repeat within 4 weeks in the same hospital***	90

* May include multiple scans per patient (same or different body parts).

** Calculated only for patients who were alive at the mid-point of follow-up period; patients registered by OCR based on their death certificate were excluded.

*** Determined only for patients with valid institutions.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- Despite many patients having more than one CT scan performed in the six months peri-diagnosis, repeated scans (within four weeks of each other) occurred in only 8% of patients (2,056/25,733). As was found for colorectal cancer patients, the percentage of scans that were repeated within four weeks decreased in the follow-up time period.

IV. Lymphoma

Exhibit 2.12a Number of inpatient/outpatient CT scans*, within six months peri-diagnosis, among Ontario lymphoma cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	n	n/pt	n	n/pt	n	n/pt
Abdomen	1,849	0.940	2,008	1.012	2,119	1.034	2,330	1.077	2,404	1.041
Brain	484	0.246	455	0.229	522	0.255	496	0.229	566	0.245
Extremities	30	0.015	22	0.011	27	0.013	19	0.009	23	0.010
Neck	336	0.171	411	0.207	500	0.244	528	0.244	620	0.268
Pelvis	1,507	0.767	1,675	0.844	1,789	0.873	2,080	0.962	2,149	0.930
Spine	71	0.036	70	0.035	75	0.037	69	0.032	82	0.035
Thorax	1,376	0.700	1,546	0.779	1,735	0.846	1,876	0.867	1,979	0.857
Total	5,653	2.875	6,187	3.118	6,767	3.301	7,398	3.420	7,823	3.387

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 10,473

***n/pt = Number of scans per patient's primary

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

Exhibit 2.12b Number of outpatient MRI scans*, within six months peri-diagnosis, among Ontario lymphoma cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	n	n/pt	n	n/pt	n	n/pt
Abdomen	sp****	sp	7	0.004	sp	sp	14	0.006	10	0.004
Brain	45	0.023	52	0.026	75	0.037	46	0.021	57	0.025
Extremities	13	0.007	16	0.008	13	0.006	18	0.008	23	0.010
Neck	6	0.003	sp	sp	15	0.007	12	0.006	17	0.007
Pelvis	7	0.004	6	0.003	sp	sp	8	0.004	6	0.003
Spine	27	0.014	36	0.018	39	0.019	69	0.032	57	0.025
Thorax	sp	sp	sp	sp	7	0.003	sp	sp	9	0.004
Total	107	0.054	119	0.060	158	0.077	171	0.079	179	0.077

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 10,473

***n/pt = Number of scans per patient's primary

****sp = Cells with counts of five or less were suppressed to protect patient confidentiality

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- From 1998–2002, there were significant increases in the numbers of CT scans of the abdomen, neck, pelvis, spine and thorax, which were performed for patients with lymphoma in the six-month peri-diagnosis period.
- The number of MRI scans remained very low during this period, with only MRI of the spine showing a significant increase.

Exhibit 2.13 Number and age- and sex-standardized* rates of inpatient/outpatient CT scans and outpatient MRI scans, within six months peri-diagnosis, per 1,000 Ontario lymphoma cancer patients diagnosed in 2002, by Local Health Integration Network**

Local Health Integration Network		CT Scans Based on Patient's Residence				MRI Scans Based on Patient's Residence			
		Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank	Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank
1.	Erie St. Clair	333	120	2,803.1	12	6	120	39.0	13
2.	South West	529	208	2,637.2	13	10	208	51.7	11
3.	Waterloo Wellington	372	110	3,299.8	8	sp***	110	sp	14
4.	Hamilton Niagara Haldimand Brant	1,028	289	3,590.0	6	24	289	87.2	5
5.	Central West	363	95	3,781.6	3	8	95	71.0	7
6.	Mississauga Halton	596	169	3,326.1	7	11	169	62.3	9
7.	Toronto Central	859	220	3,887.2	1	20	220	93.6	3
8.	Central	900	236	3,766.0	4	15	236	63.0	8
9.	Central East	856	240	3,611.3	5	21	240	86.4	6
10.	South East	374	114	3,101.8	10	21	114	194.0	1
11.	Champlain	754	190	3,862.2	2	23	190	107.9	2
12.	North Simcoe Muskoka	245	77	3,222.2	9	Sp	77	sp	12
13.	North East	426	147	3,018.3	11	8	147	55.7	10
14.	North West	146	64	2,321.5	14	6	64	89.1	4
	OVERALL	7,781	2,279	3,414.2	-	180	2,279	79.0	-
	Extremal Quotient (EQ)	**1.7**				**5.4**			

* Standardized to the number of cancer primaries (more than one per patient possible) registered in 2002 in Ontario.

** May include multiple scans per patient (same or different body parts).

***sp = Cells with counts of five or less were suppressed to protect patient confidentiality.

n = Total number of scans = 10,473

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan and Registered Persons Database; Statistics Canada - 2001 Census and Postal Code Conversion File

- There was a 1.7-fold difference in the rate of CT scans performed in lymphoma patients when comparing the LHIN with the highest rate to the LHIN with the lowest rate.
- For MRI scans, there was a 5.4-fold difference between the LHIN with the highest rate and the LHIN with the lowest rate

Exhibit 2.14 Number of inpatient/outpatient CT scans, outpatient MRI scans and liver ultrasound scans* from three months before and up to three years after the date of diagnosis, among Ontario lymphoma cancer patients diagnosed between 1998–2002

Any of CT/MRI/Abdominal Ultrasound Scan**	Number of Patients		Number of Scans	
	n	Percentage		
6 months peri-diagnosis (91 days before and up to 91 days after the date of diagnosis)				
No scan	1,091	10.4%	CT	34,352
1 scan	743	7.1%	MRI	739
2+ scans	8,611	82.4%	Abdominal ultrasound	4,666
4 to 12 months (92–365 days) after the date of diagnosis				
No scan	2,009	23.6%	CT	31,825
1 scan	732	8.6%	MRI	884
2+ scans	5,776	67.8%	Abdominal ultrasound	1,992
Between 1 and 2 years (366–730 days) after the date of diagnosis				
No scan	2,513	33.2%	CT	22,370
1 scan	790	10.4%	MRI	728
2+ scans	4,264	56.3%	Abdominal ultrasound	2,127
Between 2 and 3 years* (731–1,095 days) after the date of diagnosis**				
No scan	2,968	42.5%	CT	15,526
1 scan	796	11.4%	MRI	517
2+ scans	3,219	46.1%	Abdominal ultrasound	1,676

* May include multiple scans per patient (same or different body parts).

** Calculated only for patients who were alive at the mid-point of follow-up period; patients registered by OCR based on their death certificate were excluded.

*** Some follow-up data may be missing for patients diagnosed in 2002.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- Over 90% of lymphoma patients had some type of imaging during the six-month peri-diagnosis period. During the follow-up period, the percentage of patients who had scans decreased over time.

V. Prostate cancer

Exhibit 2.15a Number of inpatient/outpatient CT scans*, within six months peri-diagnosis, among Ontario prostate cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	N	n/pt	n	n/pt	N	n/pt
Abdomen	1,077	0.185	1,247	0.209	1,409	0.213	1,789	0.239	1,744	0.245
Brain	230	0.039	289	0.048	300	0.045	362	0.048	317	0.044
Extremities	8	0.001	9	0.002	12	0.002	22	0.003	19	0.003
Neck	8	0.001	sp****	sp	9	0.001	8	0.001	13	0.002
Pelvis	1,419	0.244	1,674	0.280	1,815	0.275	2,080	0.278	1,929	0.271
Spine	69	0.012	86	0.014	102	0.015	103	0.014	90	0.013
Thorax	86	0.015	134	0.022	152	0.023	212	0.028	181	0.025
Total	2,897	0.497	3,443	0.577	3,799	0.575	4,576	0.613	4,293	0.602

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 33,001

***n/pt = Number of scans per patient's primary

****sp = Cells with counts of five or less were suppressed to protect patient confidentiality

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

Exhibit 2.15b Number of outpatient MRI scans*, within six months peri-diagnosis, among Ontario prostate cancer patients diagnosed between 1998–2002, by type of scan

Cancer Site	1998		1999		2000		2001		2002	
	n**	n/pt***	n	n/pt	n	n/pt	n	n/pt	n	n/pt
Abdomen	sp****	sp	sp	sp	8	0.001	10	0.001	16	0.002
Brain	11	0.002	20	0.003	13	0.002	21	0.003	25	0.004
Extremities	sp	sp	sp	sp	6	0.001	10	0.001	6	0.001
Neck	sp	sp	sp	sp	sp	sp	sp	sp	sp	sp
Pelvis	26	0.004	11	0.002	20	0.003	22	0.003	29	0.004
Spine	33	0.006	30	0.005	36	0.005	43	0.006	46	0.006
Thorax	sp	sp	sp	sp	sp	sp	sp	sp	sp	sp
Total	75	0.013	71	0.012	84	0.013	106	0.014	124	0.017

* May include multiple scans per patient (same or different body parts).

**n = Total number of scans = 33,001

***n/pt = Number of scans per patient's primary

****sp = Cells with counts of five or less were suppressed to protect confidentiality

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- From 1998–2002, there were significant increases in the numbers of abdominal, pelvic and thorax CT scans, which were performed on prostate cancer patients in the six-month peri-diagnosis period.
- There was a very slight increase in the rate of all types of MRI scans performed on prostate cancer patients.

Exhibit 2.16 Number and age- and sex-standardized* rates of inpatient/outpatient CT scans and outpatient MRI scans, within six months peri-diagnosis, per 1,000 Ontario prostate cancer patients diagnosed in 2002, by Local Health Integration Network**

Local Health Integration Network		CT Scans				MRI Scans			
		Number of scans per year	Number of registered primaries	Age-sex Standardized rate* per 1,000	Rank	Number of scans per year	Number of registered primaries	Age-sex standardized rate* per 1,000	Rank
1.	Erie St. Clair	148	390	373.1	13	6	390	14.9	9
2.	South West	472	609	772.7	4	12	609	18.4	5
3.	Waterloo Wellington	243	339	724.3	6	sp****	339	sp	8
4.	Hamilton Niagara Haldimand Brant	385	829	459.5	11	10	829	12.4	10
5.	Central West	314	360	874.8	1	8	360	19.6	4
6.	Mississauga Halton	266	463	574.9	8	15	463	31.8	1
7.	Toronto Central	465	596	782.5	3	16	596	27.4	3
8.	Central	521	763	678.7	7	13	763	17.7	6
9.	Central East	437	898	490.0	10	11	898	12.3	11
10.	South East	156	342	458.9	12	4	342	11.4	12
11.	Champlain	323	604	542.9	9	19	604	28.9	2
12.	North Simcoe Muskoka	203	251	800.0	2	sp	251	sp	13
13.	North East	316	425	738.9	5	7	425	16.4	7
14.	North West	62	165	367.7	14	-	165	-	-
	OVERALL	4,311	7,034	612.9	-	127	7,034	18.1	-
	Extremal Quotient (EQ)	**2.4**				**7.8**			

* Standardized to the number of cancer primaries (more than one per patient possible) registered in 2002 in Ontario.

** May include multiple scans per patient (same or different body parts).

*** No MRIs were performed among prostate cancer patients in North West in 2002.

****sp = Cells with counts of five or less were suppressed to protect patient confidentiality

n = Total number of scans = 33,001

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan and Registered Persons Database; Statistics Canada - 2001 Census and Postal Code Conversion File

- There was a 2.4-fold difference in the rate of CT scans performed in prostate cancer patients between the LHIN with the highest rate and the LHIN with the lowest rate.
- For MRI scans, there was a 7.8-fold difference between the LHIN with the highest rate and the LHIN with the lowest rate.

Exhibit 2.17 Number of inpatient/outpatient CT scans, outpatient MRI and liver ultrasound scans* from three months before and up to three years after the date of diagnosis, among Ontario prostate cancer patients diagnosed between 1998–2002

Any CT/MRI/Abdominal Ultrasound Scan**	Number of Patients		Number of Scans	
	n	Percentage		
6 months peri-diagnosis (91 days before and up to 91 days after the date of diagnosis)				
No scan	17,633	53.5%	CT	19,444
1 scan	6,684	20.3%	MRI	468
2+ scans	8,620	26.2%	Abdominal ultrasound	8,039
4 to 12 months (92–365 days) after the date of diagnosis				
No scan	22,673	71.7%	CT	10,833
1 scan	4,967	15.7%	MRI	933
2+ scans	3,976	12.6%	Abdominal ultrasound	3,748
Between 1 and 2 years (366–730 days) after the date of diagnosis				
No scan	22,892	75.3%	CT	8,251
1 scan	4,236	13.9%	MRI	787
2+ scans	3,255	10.7%	Abdominal ultrasound	4,765
Between 2 and 3 years* (731–1,095 days) after the date of diagnosis**				
No scan	22,121	76.1%	CT	7,772
1 scan	4,016	13.8%	MRI	759
2+ scans	2,948	10.1%	Abdominal ultrasound	4,307

* May include multiple scans per patient (same or different body parts).

** Calculated only for patients who were alive at the mid-point of follow-up period; patients registered by OCR based on their death certificate were excluded.

*** Some follow-up data may be missing for patients diagnosed in 2002.

Data sources: Cancer Care Ontario - Ontario Cancer Registry; Ministry of Health and Long-Term Care - Ontario Health Insurance Plan

- Fewer than 50% of patients with prostate cancer had some type of imaging scan in the six-month peri-diagnosis period. Fewer than 30% of patients had scans during the follow-up period.

Discussion

Disease-specific utilization

An optimal rate of utilization will vary by type of cancer and the stage of disease at presentation. The Ontario Cancer Registry (OCR) does not track cancers by their stage at diagnosis, making radiology needs projections difficult to determine. Further studies are needed to determine the correct imaging utilization rate for cancer patients. However, this study can serve as a baseline for rates of radiology utilization.

Breast cancer

Current Cancer Care Ontario (CCO) guidelines recommend operative staging for breast cancer first, and then selective diagnostic radiology based on the operative stage of the cancer. The Surveillance, Epidemiology and End Results (SEER) program of the National Institutes of Health (NIH) in the United States (U.S.) collects information regarding cancer incidence and survival among nine different regions of the U.S. Prior studies have suggested that the incidence of most cancer types are similar between Ontario and the regions studied in the SEER data.[5] The SEER database shows that from 1998–2002, 51% of breast cancer patients presented with Stage I disease; 38% with Stage II; and 11% with Stage III or IV disease. According to a recent ICES study, approximately 20% of Stage II breast cancer patients had >4 positive nodes.[6] For Stage II disease with four or more positive nodes and Stage III/IV disease, CCO guidelines recommend post-operative staging: abdominal ultrasound, chest radiograph and bone scan.[7] Therefore, approximately 20% of women should have staging with an abdominal ultrasound. However, there is no recommendation for Computerized Tomography (CT) or Magnetic Resonance Imaging (MRI) in the CCO guidelines.

Exhibit 2.3 shows that 62% of women had some type of scan during the six months peri-diagnosis, which is a higher percentage than would be expected if the SEER stage presentation is similar in Ontario. In the follow-up period, abdominal CT scan was the most frequently ordered scan. Our study is unable to determine the reason the scan was ordered because this information is not in the administrative data at ICES. Physicians taking care of cancer patients appropriately have a lower threshold to order CT or MRI for common complaints such as abdominal pain or headaches. However, utilization in this case seems to exceed what is recommended in CCO guidelines. Further examination will be necessary to determine the reason for the apparent difference between the guidelines and actual utilization.

Colorectal cancer

Appropriate staging of colorectal cancer (CRC) includes an evaluation for metastatic disease. This evaluation would include an ultrasound or CT of the liver, as well as a chest radiograph for all patients, except for those who present with obvious metastases. Therefore, a rate of 0.769 abdominal CT scans per colorectal patient in 2002 seems appropriate (Exhibit 2.4a). Exhibit 2.6 shows that 24.5% of patients received no staging ultrasound, CT or MRI, which might be consistent with the number of patients who are staged operatively, or present with obvious metastatic disease.

The SEER database shows that from 1998–2002, 24% of CRC patients presented with Stage I disease; 30% with Stage II; 27% with Stage III; and 19% with Stage IV. CCO guidelines for surveillance of curatively resected CRC recommend consideration of abdominal imaging for Stage IIB and Stage III CRC patients. Therefore, the 50.3–54.8% rate of CT, MRI and ultrasound that is found in the follow-up period appears appropriate. However, it is apparent that there are large regional variations in the rate of CT scans. For CRC patients in the Toronto Central Local Health Integration Network (LHIN), there are over 2.5 scans performed per patient on average, whereas in the North West LHIN, there are 0.73 scans performed per patient on average.

Repeat CT scans occur in approximately 10% of CRC patients in the peri-diagnosis period. When considering all types of scans, there are repeats in up to 21% of cases. Many patients would have had a surgical resection during this period, and repeat scans may have been performed for symptoms or to

evaluate post-operative complications. Moreover, when considering all types of scans, there may be appropriate indications for "repeats", such as performing an ultrasound as a screening test for metastatic disease, then performing a CT scan as a more sophisticated diagnostic test. The percentage of repeated tests decreased during the follow-up period.

Lung cancer

There are two main histology types of lung cancer: small cell and non-small cell. Both are "imaging intensive" cancers. This is demonstrated by the higher overall age-sex standardized rate of CT and MRI use when compared with the many other cancers.

Small cell lung cancer accounts for approximately 15% of all lung cancer patients. These patients are routinely staged with complete body imaging, since the majority is known to present with metastatic disease.

The remaining 85% of lung cancer cases are non-small cell. Guidelines have been published on the staging requirements for non-small lung cancer.[8-10] Most agree that a CT chest and upper abdomen scan is required for all patients regardless of stage. In the absence of signs or symptoms of metastatic disease, additional staging (e.g. bone scan, brain imaging) is not necessarily required for early stage disease (approximately one-third of non-small cell lung cancer). Another one-third of cases are comprised of locally advanced disease. Over the past decade, this group of patients has seen the biggest change in disease management strategy, which has led to increasingly aggressive treatment for selected patients. As a result, guidelines have suggested more intensive imaging investigations to rule out metastatic disease prior to embarking on aggressive treatment. Most notably, the addition of brain scanning has been recommended, even in asymptomatic patients. This is reflected in practice patterns, with brain MRI rates having increased over the past five years.

There were many patients with more than one thorax scan in the six-month peri-diagnosis period. This number may be high for two reasons: patients with locally advanced disease require accurate information to make decisions; and, physicians are often required to repeat out-of-date images in order to make a treatment decision. This would suggest that wait times for appointments with thoracic surgeons and medical and radiation oncologists be assessed.

In a recent study, lung cancer patients had a longer wait time from surgical consultation to operation than did breast cancer and colorectal cancer patients.[4] If the wait time for a surgical consultation appointment is proportionally long, then scans may be out-dated by the time of the appointment or operation, necessitating a repeat scan. For patients with advanced disease, scans may be re-assessed to determine the response to chemotherapy, which may account for some of the scans. The rate of scans repeated within four weeks was 8% in the peri-diagnostic period, with most of these occurring within the same institution. As was the case with repeat CT scans for colon cancer patients, these scans may have been performed for post-operative complications or evaluation of symptoms.

Lymphoma

Complete CT staging is required for the majority of newly-diagnosed lymphoma patients to make appropriate treatment recommendations. It is not surprising that the per-patient-use of CT imaging was higher for lymphoma than for other tumour sites. For example, staging CT of the chest, abdomen and pelvis (three scans), and possibly including the neck (four scans), would be a common and appropriate set of investigations for the most common types of lymphoma. It is likely appropriate that the average number of scans per patient in the six-month peri-diagnosis period is 3.39 scans/patient. The low utilization of MRI appears to reflect the occasional occurrence of disease in the brain, the bones, or in the spinal canal/vertebrae, in which case the extent of disease is best characterized with MRI.

The appropriate utilization of imaging in follow-up is more controversial. Studies of lymphoma patients in follow-up found that 5.4–13% of relapses were detected by the use of routine imaging tests in asymptomatic patients.[11,12] For Non-Hodgkin's lymphoma, a follow-up strategy that involved clinic visits

and the performance of tests based on clinical suspicion was 44% less expensive than the routine performance of intensive screening for relapse, though cost-effectiveness was not evaluated.[12] It is noted that in Ontario, 48% of lymphoma patients underwent at least one CT scan in the two-three year interval following diagnosis, and 58% underwent a CT scan, an MRI scan or a liver ultrasound. As noted above, the indication for these scans is unknown, and further investigation is required to establish the proportion done to investigate symptoms versus those done for routine relapse screening.

Prostate cancer

Clinical T stage, Gleason grade, and serum prostate-specific antigen (PSA) level are important pre-treatment prognostic variables in prostate cancer. Higher values of these three variables signify an increased likelihood of lymph node metastases.[13] Studies suggest that imaging is not useful in patients at lower risk for metastases, because of a low likelihood of positive radiologic findings. It has therefore been recommended that appropriate staging for newly-diagnosed prostate cancer be tailored to a patient's risk grouping, and that imaging only be performed in high-risk patients.[14-16]

However, only a few organizations have adopted guidelines regarding appropriate staging for incident prostate cancer[17-19], and the definition of high- and low-risk groups is somewhat variable among them. For example, the cut-off used to distinguish "high-risk" from "low-risk" PSA varies from 10 to 30 ng/mL. This lack of consensus makes it difficult to state definitively which patients should undergo imaging studies for staging.

Furthermore, there is little information on the proportion of patients falling into the high-risk vs. lower-risk categories to help determine the appropriate level of imaging usage for prostate cancer. Most patients presenting (90–92%) in the U.S. are stage T2 or less; 55–58% of patients had PSA less than 10; and, 62–68% of patients had Gleason sum of 6 or less.[14,20] Thus, there may well be some level of imaging over-utilization in low-risk patients, especially given that 12% of Canadian urologists perform CT scans routinely.[21] There may be under-utilization in high-risk groups as well.[14,22]

In a population-based U.S. study of men diagnosed in 1994–1995, 32% of patients had pelvic CT scans, which is identical to the 31.7% of patients undergoing peri-diagnostic scans in Ontario between 1998–2002 (Exhibit 2.17).[14] In addition, 5% of patients underwent MRI scans for presumed staging in the U.S., while less than 1% of patients had an MRI in Ontario (Exhibit 2.17). This does not confirm appropriateness, but suggests that the use of scans is comparable to that in other regions.

The reason for the increase in CT scanning over time seen in Exhibit 2.15a is unclear. One possible explanation is changing modes of treatment. For example, increased use of radiotherapy would lead to additional CT scans for treatment decision purposes. Further study would be required to ascertain the cause.

The regional variation seen in Exhibit 2.16 has been noted in other studies, with even greater variability elsewhere.[14,22] For example, CT usage in a U.S. study ranged from 17% of patients in Utah, to 61% in Connecticut.[14] Regional differences in that study persisted even when an adjustment was made for differences in the use of radiation therapy.

Conclusions

The rate at which Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI) scans are ordered for cancer patients is increasing at a slightly lesser rate than the rate of increase for CT and MRI scans in the general population. It is not clear if the rapid increase of CT and MRI scans in the general population is affecting access to imaging for cancer patients.

In general, the data suggest that there were appropriate rates of CT and MRI imaging ordered for the top five cancers in Ontario as a whole. In order to further understand differences in utilization within disease-specific groups, we require data on the presenting stage of the cancer and the indication of the scan, neither of which is available in existing datasets.

Information regarding the indication for a scan will be necessary to understand the reason for an 8–10% repeat scan rate within colorectal and lung cancer diagnostic scanning. Further studies are needed to determine the correct rate of CT and MRI scans, and the appropriateness of the scans that are ordered.

Differences in utilization between Local Health Integration Networks (LHINs) and patient migration to different LHINs should be studied further. As well, the reasons behind the current patient migration patterns to LHINs outside of the patient's own LHIN for the purposes of accessing CT and MRI imaging should be examined and considered when planning the location of new CT and MRI scanners. Early analysis suggests that differences in guideline compliance and the availability of resources may contribute to the usage variance between LHINs.

However, as mentioned previously, better understanding of disease stage is also required. Compliance with guidelines is a potential area of focus for future knowledge transfer initiatives. It is noted that Cancer Care Ontario (CCO) is currently updating its guidelines for the use of diagnostic imaging for a number of cancer types.

Appendix A–Identification of CT/MRI/Ultrasound Scans from OHIP

Computerized Tomography (CT) (inpatients and outpatients)

Only professional codes (suffix C) and services that were deemed valid and reimbursed by the Ontario Health Insurance Plan (OHIP), including some shadow billing, were included.

Fee codes (OHIP):

ABDOMEN
X126 CTT - abdomen - with/out I.V. contrast
X409 CTT - abdomen - without I.V. contrast
X410 CTT - abdomen - with I.V. contrast

EXTREMITIES
X127 CTT - extremities (one or more) - with/out I.V. contrast
X412 CTT - extremities (one or more) - without I.V. contrast
X413 CTT - extremities (one or more) - with I.V. contrast

HEAD
X188 CTT - head - with/out I.V. contrast
X400 CTT - head - without I.V. contrast
X401 CTT - head - with I.V. contrast
X402 CTT - complex head - without I.V. contrast (see also preamble)
X405 CTT - complex head - with I.V. contrast
X408 CTT - complex head - with/out I.V. contrast

NECK
X124 CTT - neck - with/out I.V. contrast
X403 CTT - neck - without I.V. contrast
X404 CTT - neck - with I.V. contrast

PELVIS
X231 CTT - pelvis without I.V. contrast
X232 CTT - pelvis with I.V. contrast
X233 CTT - pelvis with/out I.V. contrast

SPINE
X128 CTT - spine - with/out I.V. contrast
X415 CTT - spine - without I.V. contrast
X416 CTT - spine - with I.V. contrast

THORAX
X125 CTT - thorax - with/out I.V. contrast
X406 CTT - thorax - without I.V. contrast
X407 CTT - thorax - with I.V. contrast

Same-day duplicates were removed. We allowed only one body part-specific CT scan per patient per day regardless of the number of physicians, institutions and fee codes billed on that day for that patient.

Magnetic Resonance Imaging (MRI) scans (outpatients only)

Only professional codes (suffix C) and services that were deemed valid and reimbursed by OHIP, including some shadow billing, were included.

Only the base codes (X421, X431, X441, X451, X461, X471, X488, X490, X493, X496) were considered to be the MRI scans (visits). MRI scan repeats (X425, X435, X445, X455, X465, X475, X489, X492, X495, X498) should not appear independently and they were not considered to be separate MRI scans. Extra services such as Cardiac gating (X486), Gadolinium (X487) and 3D MRI (X499) should not appear independently and they were not considered to be separate MRI scans.

Fee codes (OHIP):

ABDOMEN
X451 Mag. Res. Im. - abdomen – multi-slice S.E. (1 or 2 echos)

BRAIN
X421 Mag. Res. Im. - head – multi-slice S.E. (1 or 2 echos)

EXTREMITIES
X471 Mag. Res. Im. - extremities – multi-slice S.E. (1 or 2 echos)
X488 Mag. Res. Im. - multiple extremities - multi-slice sequence

NECK
X431 Mag. Res. Im. - neck – multi-slice S.E. (1 or 2 echos)

PELVIS
X461 Mag. Res. Im. - pelvis – multi-slice S.E. (1 or 2 echos)

SPINE
X490 Mag. Res. Im. ltd. spine (one segment) – multi-slice S.E. (1 or 2 echos)
X493 Mag. Res. Im. intermediate spine (2 adjacent segments) – multi-slice S.E.
X496 Mag. Res. Im. complex spine (2 or more non-adjacent segments) – multi-slice S.E.

THORAX
X441 Mag. Res. Im. - thorax – multi-slice S.E. (1 or 2 echos)

Same-day duplicates were removed. For the body parts with more than one base code (brain, 2 and extremities, 3), we allowed multiple MRI scans on the same day for the same patient as they do not occur frequently. For all other scans with only one base code, we allowed only one body part-specific MRI scan per patient per day regardless of the number of physicians, institutions and fee codes billed on that day for that patient.

Liver ultrasounds (outpatients only)

Only professional codes (older scans represent a combination of technical and professional fees, so both were included) and services that were deemed valid and reimbursed by OHIP, including some shadow billing, were included.

We only included liver ultrasounds because they are an important part of the follow-up process among cancer patients.

Fee codes (OHIP):

ABDOMEN COMPLETE
J135 DIAG. US. Abdomen/Retroperitoneum - abdom. scan, complete
J435 DIAG. US. Abdomen/Retroperitoneum - abdom. scan, complete

ABDOMEN LIMITED
J128 DIAG. US. Abdomen/Retroperitoneum - abdom. scan ltd. study
J428 DIAG. US. Abdomen/Retroperitoneum - abdom. scan ltd. study

Same-day duplicates were removed. We allowed only one body part-specific ultrasound per patient per day regardless of the number of physicians, institutions and fee codes billed on that day for that patient.

Assigning missing institutions to all scans

When multiple fee codes were billed on the same day (by one or more physicians) for the same scan, we chose the highest institution number for that scan. For the majority of such cases, that meant a newer (merged, updated, etc.) Ministry of Health and Long-Term Care (MOHLTC) institutional code. If the institution number was missing, we looked at similar scans performed on the same day (for same or different body parts), and if we found a valid institutional number, we assigned it to that scan. Remaining scans with missing institutions were linked to their respective hospital corporations by a group number used for reimbursement purposes by the MOHLTC. Group-number linking files were provided by the MOHLTC.

Appendix B—How the Research was Done

Institute for Clinical Evaluative Sciences (ICES) researchers identified all patients registered with at least one cancer primary (originating site of the cancer) (ICD-9 140–208) between 1993 and 2002 using the Ontario Cancer Registry (OCR) files, provided by Cancer Care Ontario (CCO). The OCR is a population-based cancer registry that contains demographics, date of diagnosis, diagnostic codes and pathology reports on new cancer cases in Ontario. Then, only those patients with a valid Ontario Health Insurance Plan (OHIP) number were selected to ensure that complete data from the Registered Persons Database (RPDB) could be obtained. The RPDB contains contact and administrative data for all OHIP beneficiaries. The age, sex and date of diagnosis for each patient were obtained directly from the OCR file. Patients' postal codes were obtained from the RPDB, and patients were assigned to specific Local Health Integration Networks (LHINs) by their postal code. Neighbourhood income quintiles were calculated using Postal Code Conversion File Plus (Ottawa: Statistics Canada; 2001) that incorporates Canadian census data. For deceased patients, the date of death was also collected from the RPDB.

Next, OHIP files (Appendix A) were used to determine the total number of inpatient and outpatient Computerized Tomography (CT) scans, outpatient Magnetic Resonance Imaging (MRI) scans, and outpatient abdominal ultrasound scans within three months of, and up to five years following, the date of diagnosis. The time period from three months prior to and three months after the date of diagnosis was defined as six months "peri-diagnosis". This six-month period should reflect the initial workup and staging of most cancer treatments. Inpatient MRI and ultrasound scans are billed to hospital global budgets and therefore cannot be accounted for using databases currently available at ICES. Abdominal ultrasounds were included in the analyses because they are important in staging and surveillance for some cancer patients in order to detect liver metastases.

A high number of scans (more than 99%) had a valid referring physician number that was linkable to physicians' specialties using the Corporate Provider Database (CPDB). The CPDB contains information on physician demographics, specialty training and practice location. Physician specialty was matched by year of the scan and reported physician specialty, and was then presented as the number of scans per physician by referring specialty. Multiple physicians could be identified for each scan as the referring and consultant physicians listed for each scan were included.

Using data that was obtained from an earlier ICES study,[1] we determined the percentage of scans that was performed in a given year for patients with a diagnosis of cancer, versus the number of scans that was obtained for the entire Ontario population for that same year. Scans that were performed three months prior to the date of diagnosis and up to five years after the date of diagnosis were considered to be performed for cancer indications. The rate of increase in cancer scans and scans in the general population were calculated.

Five age groups (0–39, 40–64, 65–74, 75–85, and 85+ years) were used to calculate age- and sex-standardized rates for scans for each LHIN, based on the patient's area of residence and on the location of the institution where the scans were performed. Only scans with valid institutional codes were included in these analyses (93.6% of CT and 97.2% of MRI scans). For any LHIN in which five or fewer cancers were registered, the data was suppressed as per ICES' protocol to protect patient confidentiality. We also calculated age- and sex-standardized rates for CT and MRI scans based on patients' neighbourhood income quintiles. Analyses were standardized to the number of cancer primaries (since more than one per patient was possible) registered for that year for each LHIN.

For the cancer-specific analyses, we limited our study cohort to patients registered between 1998 and 2002 with one of the five most common cancers in Ontario for that time period. They were: female breast, coded as ICD-9 174; colorectal, ICD-9 153 and 154; lung, ICD-9 162; lymphoma, ICD-9 200–202; and, prostate, ICD-9 185. To fit the assumption that a scan was performed for a particular type of cancer, only patients with single primaries for whom the histologic behavior was reported as a malignant tumour in a

primary site were included. A patient was considered to have a single primary when there was no record of registration in the OCR database for another primary up to three years prior to the current registration. Each patient was tracked for up to three years after the date of diagnosis and CT, MRI and abdominal ultrasound scans were identified. Scans are presented only for patients who were alive until at least the mid-point of each follow-up period, therefore, the number of patients decreases in each subsequent period. Patients registered by OCR based on their death certificate, when a date of diagnosis was equal to the date of death, were excluded from the follow-up analyses. Also presented are repeat scans for primaries with a high number of scans (colorectal and lung) for the most relevant body parts. A scan was considered to be a repeat when there were two scans for the same body site within four weeks of each other. When determining repeat scans in the same institution, only those scans with valid institutional codes were included. CT, MRI and abdominal ultrasound scans performed on the same day were not considered to be repeats.

Limitations

There are several limitations to this type of study. As mentioned above, there is no record of the indication for the scan. All scans that were performed within five years after a diagnosis of cancer were presumed to be for a cancer indication, which will overestimate the number of scans performed for cancer. The rate of MRI for cancer was likely slightly underestimated because there is no separate OHIP billing for MRI scans performed for inpatients. The billing data only reported scans that were performed within Ontario. Scans that were performed outside of the province or country were not captured in the data. Hospitals that compensate physicians through an Alternative Funding Plan (AFP), such as the Southeastern Ontario Academic Medical Organization (SEAMO), may have under-reported the rate of scans.

References

1. Laupacis A, Keller MA, Przybysz. CT and MRI Scanning. In: Tu JV, Pinfold SP, McColgan P, Laupacis A, editors. Access to Health Services in Ontario: ICES Atlas. Toronto: Institute for Clinical Evaluative Sciences; 2005.
2. Wittram C, Meehan MJ, Halpern EF, et al. Trends in thoracic radiology over a decade at a large academic medical center. *J Thorac Imaging* 2004; 19:164–170.
3. Bhargavan M, Sunshine JH. Utilization of radiology services in the United States: levels and trends in modalities, regions, and populations. *Radiology* 2005; 234:824–832.
4. Simunovic M, Theriault ME, Paszat L, et al. Using administrative databases to measure waiting times for patients undergoing major cancer surgery in Ontario, 1993-2000. *Can J Surg* 2005; 48:137–142.
5. Mackillop WJ, Zhang-Salomons J, Boyd CJ, et al. Associations between community income and cancer incidence in Canada and the United States. *Cancer* 2000; 89:901–912.
6. Benk V, Przybysz R, McGowan T, Hodgson D, Bondy SJ, Wong R et al. Delays in Radiation Therapy for Cancer. 2004.
7. Members of the Breast Cancer Disease Site Group. Baseline Staging Tests in Primary Breast Cancer. Cancer Care Ontario, 2003.
8. Pfister DG, Johnson DH, Azzoli CG, et al. American Society of Clinical Oncology treatment of unresectable non-small-cell lung cancer guideline: update 2003. *J Clin Oncol* 2004; 22:330–353.
9. Silvestri GA, Tanoue LT, Margolis ML, et al. The noninvasive staging of non-small cell lung cancer: the guidelines. *Chest* 2003; 123:147S–156S.
10. Scottish Intercollegiate Guidelines Network (SIGN). Management of Patients with Lung Cancer. 2005.
11. Radford JA, Eardley A, Woodman C, et al. Follow up policy after treatment for Hodgkin's disease: too many clinic visits and routine tests? A review of hospital records. *BMJ* 1997; 314:343–346.
12. Elis A, Blickstein D, Klein O, et al. Detection of relapse in non-Hodgkin's lymphoma: role of routine follow-up studies. *Am J Hematol* 2002; 69:41–44.
13. Partin AW, Mangold LA, Lamm DM, et al. Contemporary update of prostate cancer staging nomograms (Partin Tables) for the new millennium. *Urology* 2001; 58:843–848.
14. Albertsen PC, Hanley JA, Harlan LC, et al. The positive yield of imaging studies in the evaluation of men with newly diagnosed prostate cancer: a population based analysis. *J Urol* 2000; 163:1138–1143.
15. Abuzallouf S, Dayes I, Lukka H. Baseline staging of newly diagnosed prostate cancer: a summary of the literature. *J Urol* 2004; 171:2122–2127.
16. O'Dowd GJ, Veltri RW, Orozco R, et al. Update on the appropriate staging evaluation for newly diagnosed prostate cancer. *J Urol* 1997; 158:687–698.
17. Cancer Management Guidelines for Prostate Cancer. BC Cancer Agency Website. (accessed 9-25-2005).
18. Expert Panel on Urologic Imaging. Appropriateness Criteria for Pretreatment Staging of Clinically Localized Prostate Cancer. American College of Radiology Website. (accessed 9-25-2005).
19. Practice Guidelines in Oncology for Prostate Cancer. National Comprehensive Cancer Network Website. (accessed 9-25-2005).
20. Kindrick AV, Grossfeld GD, Stier DM, et al. Use of imaging tests for staging newly diagnosed prostate cancer: trends from the CaPSURE database. *J Urol* 1998; 160:2102–2106.
21. Fleshner N, Rakovitch E, Klotz L. Differences between urologists in the United States and Canada in the approach to prostate cancer. *J Urol* 2000; 163:1461–1466.
22. Cooperberg MR, Lubeck DP, Grossfeld GD, et al. Contemporary trends in imaging test utilization for prostate cancer staging: data from the cancer of the prostate strategic urologic research endeavor. *J Urol* 2002; 168:491–495.