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ICES Institute for Clinical Evaluative Sciences

Diagnostic Services in Ontario: Descriptive Analysis and Jurisdictional Review

ICES Investigative Report

April 2007
(Revised)

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Disclaimer

This report represents the views of the authors and does not necessarily represent the views of the Diagnostic Services Committee.

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About ICES

Ontario's resource for informed health care decision-making

The Institute for Clinical Evaluative Sciences (ICES) 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.

Executive Summary

Introduction

Diagnostic services are essential components of health care. Diagnostic tests provide information about the presence or absence of disease, anatomical structure, physiologic function, severity of disease, and the risk of disease or adverse health outcomes. Throughout the twentieth century, advances in diagnostic technology have allowed for earlier, less invasive and more accurate diagnosis of potentially life-threatening disease. As a result, there has been phenomenal growth in the utilization of and expenditure for diagnostic imaging services. For instance, in the United States (US) between 1999 and 2004, overall Medicare spending on imaging rose by 88%—from US$5.8 billion to US$10.9 billion—outstripping growth in spending for other services covered by Medicare. Similarly in Canada, the proliferation of diagnostic testing over time has mirrored advancing imaging technology. In fact, there was a 300% increase in the number of computed tomography (CT) scans and a 600% increase in the number of magnetic resonance imaging (MRI) tests performed in Ontario between 1993/94 and 2003/04. Such marked increases in utilization have raised concerns about the sustainability of these levels of spending, about whether this increasing investment in diagnostic imaging services represents a wise allocation of limited resources and about whether the proliferation is indeed associated with increased medical need.

Several factors may be responsible for the increasing utilization of imaging services:

- Advances in imaging technology are providing increasingly sophisticated diagnostic and prognostic information and offer tremendous potential to improve health outcomes;
- Patients are becoming more consumer-oriented, well-informed and empowered, and are demanding more tests from their health care providers as a means of gaining information about their health;
- Physicians are ordering more tests in their practice of defensive medicine to protect themselves from the threat of litigation, to appease demanding patients, and to allay their own fears of missing a life-threatening, yet treatable disease;
- The rapid diffusion and uptake of imaging technology by physicians may be promoting a dependence on diagnostic tests to support clinical decision-making, thereby replacing the traditional clinical examination;
- The increasing sensitivity of diagnostic imaging technology has the undesired consequence of identifying abnormalities of uncertain clinical importance (“incidentalomas”), leading to a cascade of more imaging and potentially unnecessary medical interventions; and,
- In some jurisdictions, a rise in entrepreneurial activity among physicians has led to performance of diagnostic imaging in ambulatory settings by non-radiologists. Ownership of diagnostic imaging equipment by physicians may allow them to refer their own patients to imaging centres in which these physicians have a financial interest—thereby increasing their revenue.

Objectives

The Diagnostic Services Committee (DSC), with representation from the Ontario Medical Association, the Ontario Hospital Association, and the Ontario Ministry of Health and Long-Term Care (MOHLTC), was established through the Physician Services Framework Agreement. The DSC provides advice to the Minister of Health and Long-Term Care on the planning and coordination of the diagnostic services system in Ontario. One of its first priorities was to establish strategic goals and directions for Ontario’s diagnostic services system. To assist in this process, the DSC asked the Institute for Clinical Evaluative Sciences to describe the extent to which diagnostic imaging services are currently provided to patients, as well as to provide information about how Ontario manages these services in the context of other national and international jurisdictions. To this end, a descriptive analysis of the utilization of diagnostic services in Ontario and a review of the management of these services in a number of selected jurisdictions was undertaken. For the most part, this report focuses on diagnostic imaging technologies because they comprise the majority of technologically advanced, high cost and rapidly growing diagnostic services in Ontario. Laboratory and pathology services as well as genetic testing were excluded.

This report also highlights lessons, cautionary advice and recommendations for the future of Ontario’s diagnostic services system. In addition to the DSC, this document will be of interest to a broader audience of policy makers and stakeholders who share a desire to improve the effectiveness, efficiency, and quality of diagnostic services in their own jurisdictions.

About this report

The report is divided into two parts as follows:

- A descriptive analysis of the delivery of diagnostic services in Ontario; and,
- A national and international review of the management of diagnostic services (focusing on diagnostic imaging services) in other jurisdictions, followed by policy options and recommendations for Ontario.

Part I—Ontario descriptive analysis

The descriptive analysis illustrates the utilization patterns of 31 diagnostic tests in Ontario from 1996/97 to 2005/06. The tests highlighted in this report were chosen for inclusion based on their rising relative and absolute costs over time. The analysis was performed using data from the MOHLTC, including physician billing claims submitted to the Ontario Health Insurance Plan (OHIP) and the Registered Persons Database (RPDB)—the management system for all Ontario residents eligible for health care. These databases provide information about the number of tests performed on patients; however, an assessment of the appropriateness of testing was not possible since information about the clinical reason for ordering a particular test or its result was unavailable.

For the selected diagnostic tests, Part I of this report specifically addresses:

- Trends in the number of diagnostic tests used over time;
- Population rates and demographic trends;
- Geographic variations by Local Health Integration Network (LHIN);
- Patterns of repeat testing; and,
- The relationship between single and multiple tests.

Part II—Jurisdictional review

Part II of this report examines the delivery of diagnostic services, specifically imaging services, in other jurisdictions in order to inform policy on diagnostic services management in Ontario. The jurisdictions reviewed include: Canada (British Columbia, Alberta, Manitoba, Quebec); US (Medicare, Veterans Affairs, Kaiser Permanente); Europe (the United Kingdom, Germany, France, Sweden); Japan; and Australia.

Data were obtained from peer-reviewed and grey literature, as well as from interviews with experts using a structured questionnaire. In each jurisdiction, the following was examined:

- Expenditures for health care and diagnostic imaging;
- Supply of imaging technology, imaging services and human resources;
- Policy for funding and management of diagnostic imaging services; and,
- Policy for introducing, monitoring and removing diagnostic imaging technology.

The findings from the jurisdictional review were evaluated in order to elucidate overall policy options for Ontario in the areas of:

- Utilization and cost of diagnostic imaging;
- Appropriateness of diagnostic imaging;
- Intensity of diagnostic imaging and health outcomes;
- Transfer of knowledge into clinical practice; and,
- Health technology assessment.

Key findings from Ontario descriptive analysis

The major findings from the descriptive analysis of diagnostic testing in Ontario were as follows:

1. There was an increase in the number of all tests examined from 1996/97 to 2005/06; however, the magnitude of growth was variable (most marked for MRI and 72+-hour Holter monitoring, and least marked for cardiac event loop monitoring and chest and spine X-rays).

2. There was no clear evidence that growth in one test or technology served as a replacement or substitution for other (perhaps older) technologies; however, only echocardiography and cardiac nuclear wall motion studies were examined in this regard. Also, there was no clear evidence of inappropriate use of these two "test case" technologies, which have overlapping indications in the same patient population.

3. Socioeconomic disparities favouring affluent neighbourhoods were present for most tests, but were most marked for pelvic/intracavity and pregnancy ultrasounds and MRI. The reason for such socioeconomic disparities may relate to variations in health-seeking behaviours, access to specialists, physician decision-making biases or clinical differences.

4. Regional variations existed for all tests, although the magnitudes of variations were modest for most tests (most marked for sleep titration studies and cardiac nuclear perfusion tests, and least marked for chest and spinal X-rays and CT scans). None of the Local Health Integration Networks (LHINs) were consistently low-rate users or high-rate users for all tests. The regional correlation in tests providing similar diagnostic information on similar patient populations (e.g., MRI vs. CT) was poor. The proliferation of tests over time varied and did not increase uniformly across LHINs.

5. The annual prevalence of repeat testing (one or more repeat tests within one year) ranged from approximately 10% (transesophageal echocardiography) to as high as 89% (ultrasound in pregnancy), although most tests fell within the 20–40% range. The high rates of repeated pregnancy-related ultrasounds may be partially attributable to more aggressive fetal screening, patient demands, and evolving practice guidelines. The prevalence of repeat testing rose for some tests (cardiac nuclear wall motion, ultrasound in pregnancy, CT and MRI), and fell for others (sleep studies) over time.

6. Determinants of regional repeat testing variations may be explained in part by patient factors (e.g., clinical indications, disease burden, etc.). However, for some tests, determinants are complex and are likely explained by a combination of system, physician and patient factors.

7. Due to the lack of information regarding test indication and results, the extent to which utilization patterns have been appropriate or inappropriate cannot be easily ascertained, and should not be inferred from the results of the study. The observed demographic shifts in utilization among older patients over time may be consistent with more aggressive referral behaviours among patients with high underlying disease burden and/or illness complexity. The absence of any consistent high- or low-rate regional outliers may suggest that regional differences are more dependent on local factors (e.g., specialty physician supply, disease variations), than on pervasive or systematic physician referral practices. Nonetheless, due to the dramatic numbers of repeat tests and high rate of increase in repeated tests over time, pregnancy-related ultrasounds may be one area where the relationship between clinical practice and practice guidelines needs to be further examined.

8. While judgments about the appropriateness of testing may be difficult in some cases, further studies (using chart audits and/or physician/patient surveys) will help to determine the efficiency, yield or outcomes associated with inter-regional (and/or inter-physician) differences in testing intensity. Pregnancy-related and sleep studies may provide meaningful test case applications.

Recommendations and policy options for Ontario

Based on the results of the jurisdictional review of diagnostic services, the following are the recommendations and policy options for Ontario:

1. Consultation with other national and international organizations is necessary to develop a standard and comprehensive method for recording and reporting diagnostic service utilization and cost. Attention to the cost of diagnostic imaging tests themselves as well as to downstream savings and costs (e.g., from further investigations for "incidentalomas" or false positives) is required.
2. A universal, province-wide, web-based system for ordering diagnostic imaging tests should be adopted. This would allow clinicians to access the results of previous imaging tests and thus decrease the frequency of unnecessary repeat testing. The system could be built upon findings from pilot-testing in Ontario and other provinces, such as Manitoba and Nova Scotia. Real-time identification of areas where ordering appears to be incongruous with evidence-based practices could be evaluated. Until such a system is adopted, targeted chart reviews could prove useful for identifying areas where appropriateness of testing may be a concern.
3. A population-based study that seeks to understand the relationship between the intensity of diagnostic imaging use and health outcomes in Ontario is necessary in order to fully understand reports from the US Medicare population which suggest that higher spending for diagnostic imaging does not lead to improved health outcomes.
4. Investment is recommended in education related to diagnostic services on several fronts including: the public, medical school students and residents, continuing medical education (CME), diagnostic imaging ordering systems that embed clinical practice guidelines (e.g., web-based computer order entry systems), as well as continuous audit and feedback of performance to clinicians.
5. Support for the Ontario Health Technology Assessment Committee (OHTAC) should be continued, particularly for its recent and unique role in recommending field studies relating to diagnostic imaging technology. An application for OHTAC to examine obsolete and substitution diagnostic imaging technologies should be submitted.
6. Trends in the ambulatory provision of imaging services by non-radiologists should be monitored, and key stakeholders should be involved in the creation of clear guidelines regarding self-referral for diagnostic imaging.

Conclusions

Modern diagnostic imaging has rightly been hailed as one of the most important medical advances of the past century, with the potential for significant benefits to the health of Ontarians. Innovations in diagnostic technology continue at a rapid pace and are accompanied by a rapid proliferation of diagnostic testing. Yet significant increases in population rates of diagnostic testing, substantial rates of repeat testing, and regional variations in practice patterns raise questions about whether this proliferation is consistent with increased medical need. Data that are routinely collected in Ontario do not include information about diagnostic test indications or results—information that would be necessary in starting discussions about the appropriateness of current utilization patterns. The greatest challenge that lies ahead is to determine and ensure the appropriateness and cost-effectiveness of diagnostic technology. Ontario has the opportunity to develop the best methods of managing diagnostic imaging services and should be prepared to rigorously evaluate their success in the coming years.

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Background

Diagnostic services are an essential component of health care. At the provider-patient level, diagnostic testing provides information about the presence or absence of disease, about anatomical structure, physiologic function and the severity of disease, and about the future risk of disease or adverse health outcomes. In a useful diagnostic test, the results have a direct influence on decisions that could improve patient health. Results from diagnostic imaging tests can aid physicians in accurately diagnosing patients and in offering appropriate treatments or interventions. At the health care system level, diagnostic imaging results can act as a mechanism to triage patients and regulate them through the system.

Advances in diagnostic technology have allowed for earlier, less invasive and more accurate diagnosis of potentially life-threatening disease and have improved patient health outcomes in many cases. At the same time, the proliferation of advanced technology has led to substantial perceived need for these technologies, thereby markedly increasing the utilization of and expenditure for imaging services.[1-5] In the United States (US), the Medicare Payment Advisory Commission (MedPAC) reported that overall Medicare spending on imaging rose 88% between 1999 and 2004, outstripping growth in spending for other services covered by Medicare. In comparison, spending for all physician services combined in the US increased by only 31% during the same time period.[2] Available evidence has demonstrated that the proliferation of cardiac diagnostic technologies throughout the 1990s in Canada has mirrored the relative growth rates of cardiac diagnostic technologies in the US.[6] Such marked increases in utilization have raised concerns about whether these levels of spending are sustainable, whether this increasing investment in diagnostic imaging services represents a wise allocation of limited resources,[1,5,7,8] and whether the proliferation is associated with increased medical need.

Several factors may be responsible for the increasing utilization of diagnostic imaging services:

- In many developed nations, a high value is placed on the use of sophisticated technology and on the acquisition of information. Increasingly well-informed and empowered patients may demand more diagnostic information from their health care providers;[9]
- Physicians are ordering more tests to protect themselves from the threat of future litigation[8] and to allay their own fears of missing a life-threatening yet treatable disease (however low the probability of disease may be);
- Physicians increasingly depend on information gleaned from a diagnostic test to support their clinical decision-making, thereby replacing the traditional clinical examination and eroding their confidence in bedside clinical assessment skills.[10] Indeed, studies have revealed that the quality of bedside clinical skills among contemporary trainees is alarmingly poor;[11,12]
- Increased sensitivity of diagnostic tests may lead to the unwanted consequence of identifying abnormalities of uncertain clinical importance ("incidentalomas"). This can also lead to a further cascade of tests, patient stress and potentially unnecessary treatment;[13]
- Advances in diagnostic imaging technology have allowed physician entrepreneurial activity, whereby diagnostic imaging is performed in free-standing facilities or in physician offices by non-radiologists.[8] Ownership of diagnostic imaging equipment by physicians may allow them to refer their own patients to imaging centres in which these physicians have a financial interest, thereby increasing their revenue. This practice—particularly prevalent in the US—is called "self-referral"[14].

About this report

Part I of this report highlights the use of 31 diagnostic tests for the fiscal years 1996/97 to 2005/06 in Ontario. The analysis was performed using data from the Ministry of Health and Long-Term Care (MOHLTC). These tests were chosen for inclusion based on their rising relative and absolute expenditures over time. Information about the clinical reason for ordering a particular test and the associated result was not available; therefore, estimations of appropriate or inappropriate test utilization could not be made. For the most part, the report focuses on diagnostic imaging technologies because they comprise the majority of technologically advanced, high cost and rapidly growing diagnostic services in Ontario. Laboratory and pathology services as well as genetic testing were excluded.

In particular, Part I of the report highlights:

- Trends in the number of diagnostic tests used over time;
- Population rates and demographic trends;
- Geographic variations by Local Health Integration Network;
- Patterns of repeat testing; and,
- The relationship between single and multiple tests.

Part II of this report is a review of how other jurisdictions and organizations integrate and organize diagnostic testing into their health care systems. The review includes electronic information gleaned from the internet (grey literature) and from interviews with key national and international contacts. Specifically, examination of the systems in several Canadian provinces, large US health maintenance organizations, Australia, the United Kingdom, France, Sweden, Japan and Germany are highlighted.

The provision of diagnostic imaging services across jurisdictions was examined for the following components:

- Expenditures for health care and diagnostic imaging;
- Supply of imaging technology, imaging services and human resources;
- Policy for funding and management of diagnostic imaging services; and,
- Policy for introducing and monitoring new diagnostic technology (and for removing obsolete technology).

At the end of this review, recommendations and policy options are put forth to better integrate diagnostic imaging into the Ontario health care system in a more information-based and sustainable manner.

Part I
Descriptive Analysis of Diagnostic Services in Ontario

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Introduction

Advances in imaging technology provide sophisticated information to aid in the diagnosis, treatment and prognosis of many medical conditions. In some cases, the results from diagnostic imaging may even help in improving the health outcomes of patients. The appropriate use of diagnostic testing is difficult to evaluate because Ontario administrative data do not capture clinical indication, the reason a test was ordered or the results of the test. In order to close these information gaps and allow a broader understanding of the use of diagnostic imaging tests in Ontario, both collaborative research and a detailed patient chart review study are currently underway.

Part I of this report illustrates testing patterns of 31 diagnostic tests in Ontario from 1996/97 to 2005/06. These tests were chosen for inclusion based on their rising relative and absolute costs over time. The analysis was performed using data from the Ministry of Health and Long-Term Care (MOHLTC), including physician billing claims submitted to the Ontario Health Insurance Plan (OHIP) and the Registered Persons Database (RPDB)—which manages the information for Ontario residents that are eligible for universal health care.

The topics addressed in this report are:

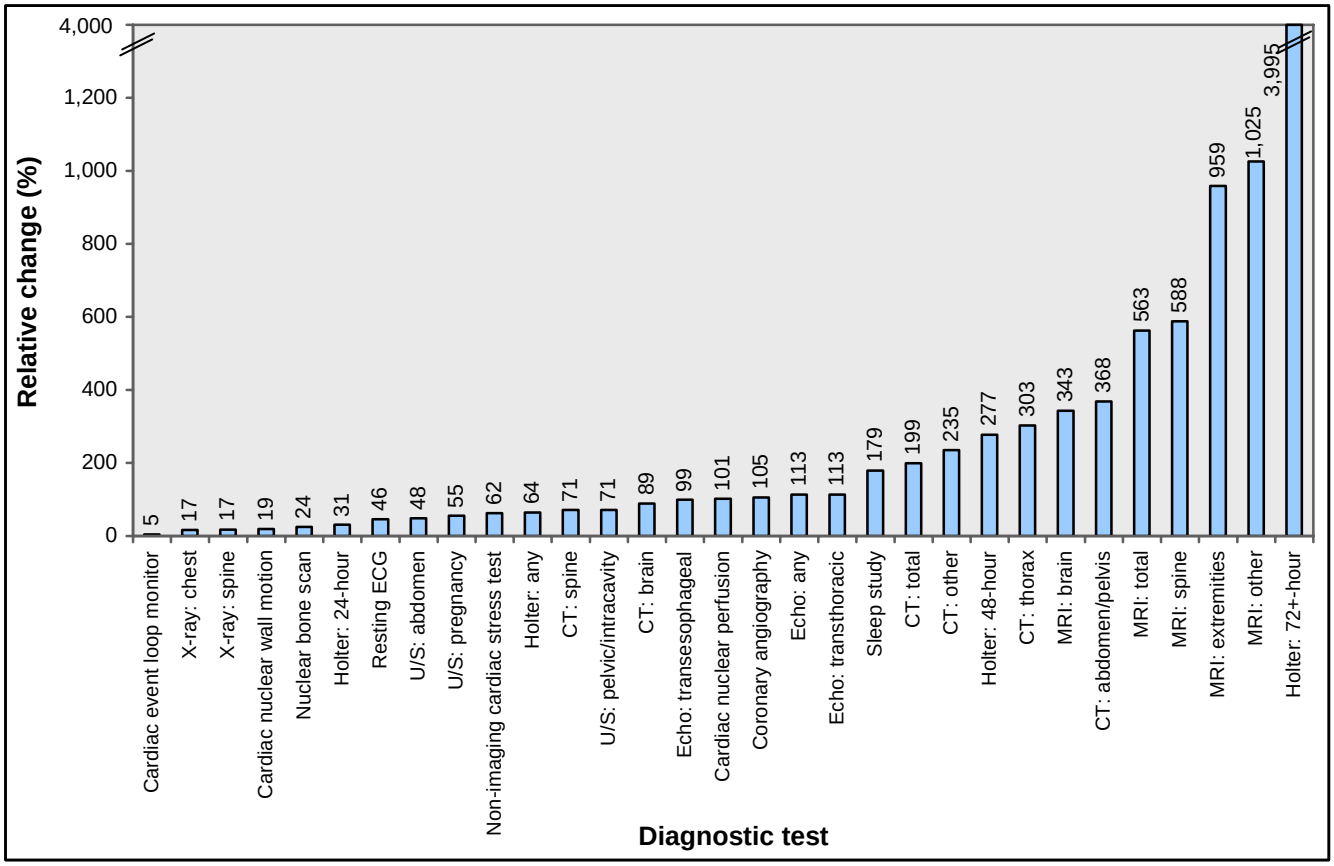
- Trends in the number of diagnostic tests used over time;
- Population rates, demographic and socioeconomic status testing trends;
- Regional variations in testing by Local Health Integration Network;
- Substitution of one test for another;
- Patterns of repeat testing; and,
- The relationship between single and multiple tests.

Findings—Chapter 1: Number of Diagnostic Tests Used Over Time

This chapter examines the absolute and relative annual changes in the number of selected diagnostic tests from 1996/97 to 2005/06.

Temporal volumes

Exhibit 1.1 Relative change (%) in the annual number of selected diagnostic tests performed, in Ontario, 1996/97 to 2005/06



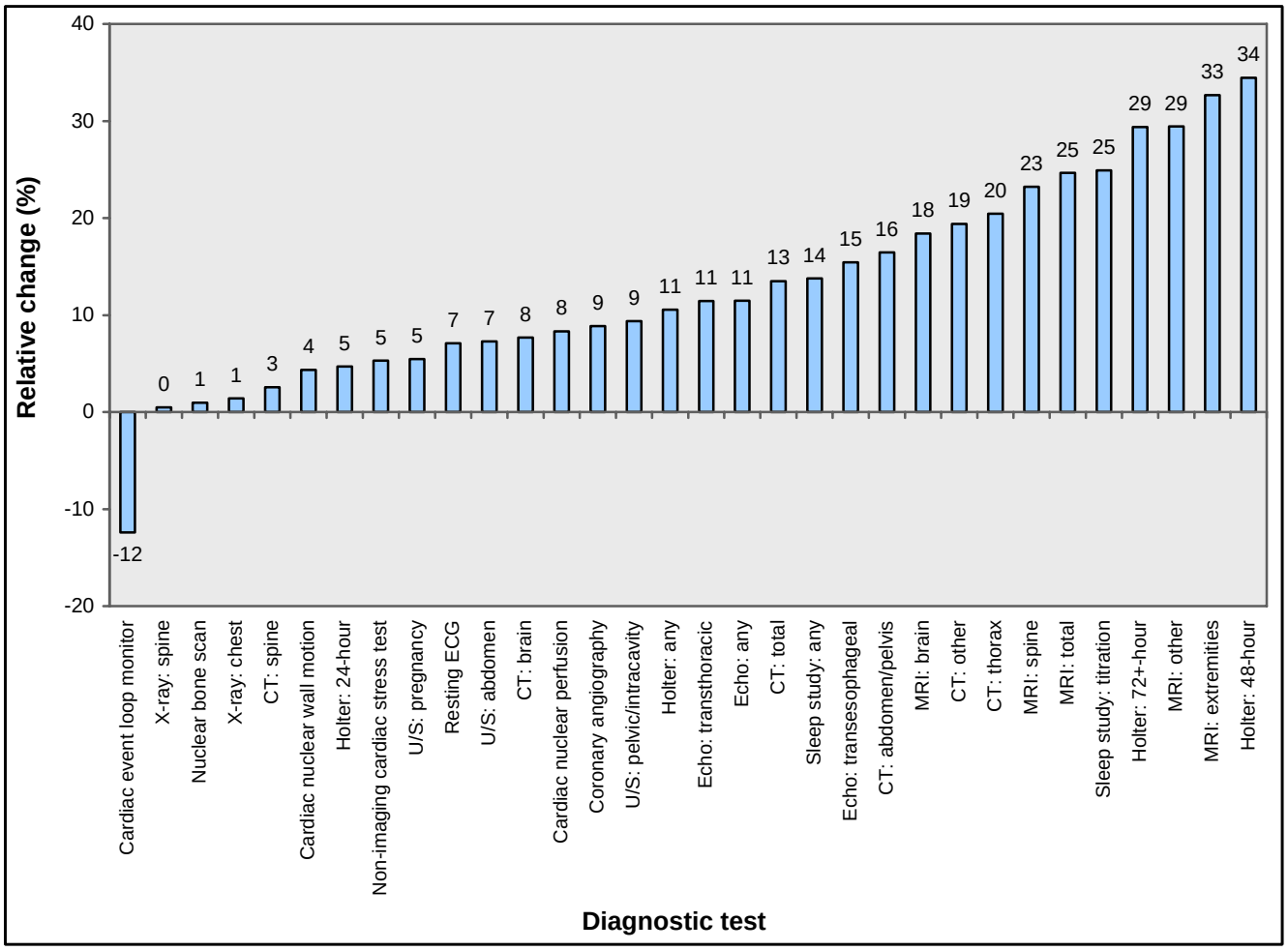
CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

For Exhibit 1.1

- Between 1996/97 and 2005/06, the annual number of all diagnostic tests increased, but the magnitude of the increase varied with the type of test.
- The smallest increases occurred in cardiac event loop monitoring (5%), chest X-rays (17%), spine X-rays (17%) and cardiac nuclear wall motion scans (19%).
- There were large increases in the annual number of MRI scans (563%) and CT scans (199%).
- The annual number of sleep studies, echocardiograms, coronary angiographies, and cardiac nuclear perfusion tests also increased substantially over the decade: 179%, 113%, 105%, and 101%, respectively.
- There were dramatic increases (>1,000%) over time in the annual number of 72+-hour Holter and MRI-other tests.

Relative annual changes

Exhibit 1.2 Relative change (%) in the annual number of selected diagnostic tests performed, in Ontario, 2004/05 to 2005/06



CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

For Exhibit 1.2

- With few exceptions, the changes in the number of tests from 2004/05 to 2005/06 were generally proportional to those seen during the decade from 1996/97 to 2005/06.
- There was little increase in the number of spine or chest X-rays over the year, while the number of MRI scans grew by 25%.
- The number of cardiac event loop monitors declined by 12% over the year, but the rates fluctuated from year to year, averaging out to a modest 10-year relative growth of 5% from 1996/97 to 2005/06. (see Exhibit 1.1).
- The number of sleep titration tests increased more than the overall number of sleep studies (25% vs. 14%) from 2004/05 to 2005/06, suggesting that more patients were placed on therapies to treat sleep disorders over time. However, it should also be noted that fee codes for physician reimbursement of sleep titration studies were only introduced in 2002/03; accordingly, disproportionate increases may also be attributable to the fact that physicians are becoming more familiar with, and are thus more frequently using, these new codes.
- Reasons for the large one-year increases in 48-hour and 72+-hour Holter monitoring (34% and 29%, respectively) are unclear. Holter monitors may have substituted for cardiac event loop monitors, which declined by 12% over the same time intervals.

Discussion

Both MRI-other and 72+-hour Holter monitoring were associated with the most dramatic changes in utilization over the past decade; however, the appropriateness associated with such increases is difficult to interpret. These increases may have been due in part to random error as well as to the methodologies used to distinguish 72+-hour Holters from other forms of ambulatory electrocardiogram (ECG) monitoring (e.g., cardiac event loop monitors). The rise in frequency of MRI-other may have been due to the multiple anatomical locations from which they are comprised.

The large increases in total MRI and CT scans likely reflect the intentional growth in capacity for these tests throughout Ontario from 1996/97 to 2005/06—Ontario rates of both procedures in the mid-1990s were well below those in other national and international jurisdictions. The disproportionate growth of MRI relative to CT may also partially reflect the substitution of one test for the other, given improved MRI precision and quality for examining soft tissue and organ structures. Despite the sharp increases in utilization, the volume of MRI and CT in Ontario still ranks below national and international averages.[15,16]

Sleep studies are performed on patients with suspected sleep disorders, whereas sleep titration tests are performed on patients with documented sleep disorders (in order to monitor their response to various therapies). For example, patients who are first diagnosed as having a sleep disorder by a sleep study may receive specific therapies, such as masks which administer continuous positive airway pressure (CPAP). Patients may require sleep titration tests in order to adjust the settings of CPAP and to ensure that the therapy is effective. The growth in the number of sleep studies may reflect improved capacity and evolving evidence for benefit, especially among those with documented sleep disorders. For instance, the utilization of sleep titration tests increased 2.18-fold over the last three years (data not shown).

While some have questioned whether the number of sleep laboratories in Ontario is inappropriately high, given that the annual rate of sleep studies per capita in Ontario ranks among the highest of any province, one recent study has estimated that the prevalence of moderate sleep apnea among at-risk populations (e.g., obese, hypertensive, habitual snorers, hypersomnolence) is at least 13% among many international jurisdictions.[17] Among these, a high proportion of patients would benefit from sleep titration tests, since they may have adverse prognostic consequences, which may be treatable.[17] However, given the absence of information about test indication and results, the extent to which sleep study referrals are appropriate and reflect underlying burden of disease is unknown. Moreover, the quality of sleep studies and the extent to which they are conducted and interpreted in a standardized fashion are also unknown.

Previous Ontario studies have demonstrated the temporal growth in echocardiography and coronary angiography.[6,18] The proliferation of both technologies has outstripped changes in disease prevalence and demographic shifts. Growth in coronary angiography reflects increased capacity and projected targets, as estimated by the Cardiac Care Network of Ontario (currently over 550 coronary angiographies per 100,000 adults).[19] Such increased capacity partially reflects evolving evidence from clinical trials in favour of percutaneous coronary interventions in the management of acute coronary care. The reason for the temporal growth of nuclear cardiac imaging is unclear, especially given these evolving management practices. In theory, these practices should have resulted in fewer ambulatory non-invasive risk-stratification investigations since patients would have already received angiography. While some have reported inappropriately high utilization rates of nuclear perfusion imaging for screening purposes in secondary prevention populations (e.g., screening for in-stent restenosis),[20] the extent to which such growth reflects inappropriate referral patterns is unknown.

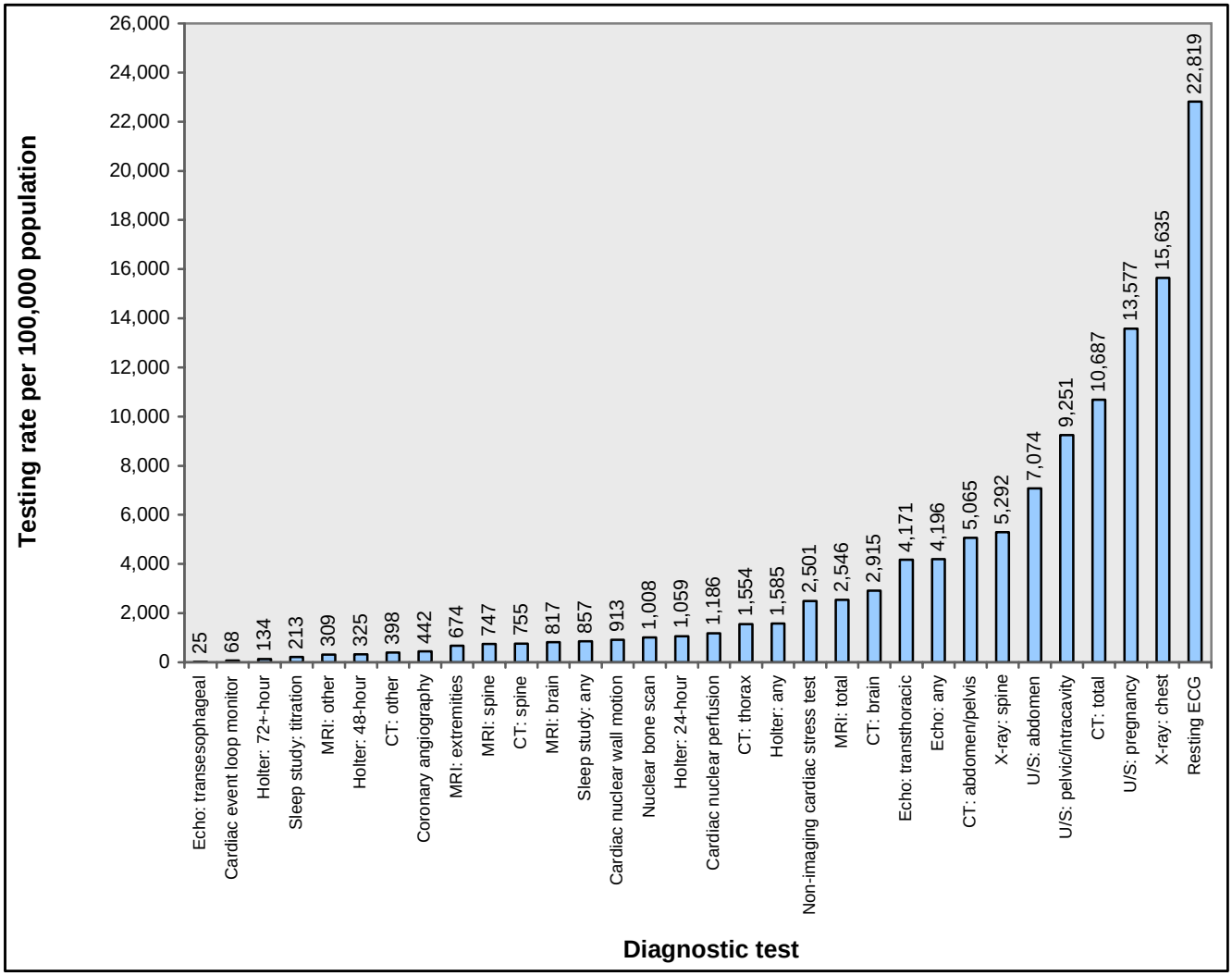
Explanations for increases in ECG are also unclear, given that this service is administered in ambulatory settings rather than being centralized. While evidence for intensive management of congestive heart failure may justify more frequent ECGs, the magnitude of rise in prevalence of echocardiography cannot be explained by changes in disease prevalence over time, by expanded clinical indications, or by evolving clinical trial evidence. Conversely, available evidence from survey data and selected chart audits suggest that a sizeable minority of echocardiography referrals in Ontario may be for lower-risk and lower-yield diseases (e.g., murmurs, screening for endocarditis prophylaxis).[21] However, the extent and proportion to which lower yield indications comprise echocardiography referrals in Ontario cannot be estimated with precision, given the lack of available data regarding test indication and evaluations regarding how the test results are ultimately used.

Chapter 2: Diagnostic Testing Rates by Population, Demographics and Socioeconomic Status

This chapter describes the population-based utilization rates of selected diagnostic tests, by age, sex, socioeconomic status, and over time.

Population rates

Exhibit 2.1 Testing rate per 100,000 population for selected diagnostic tests, in Ontario, 2005/06



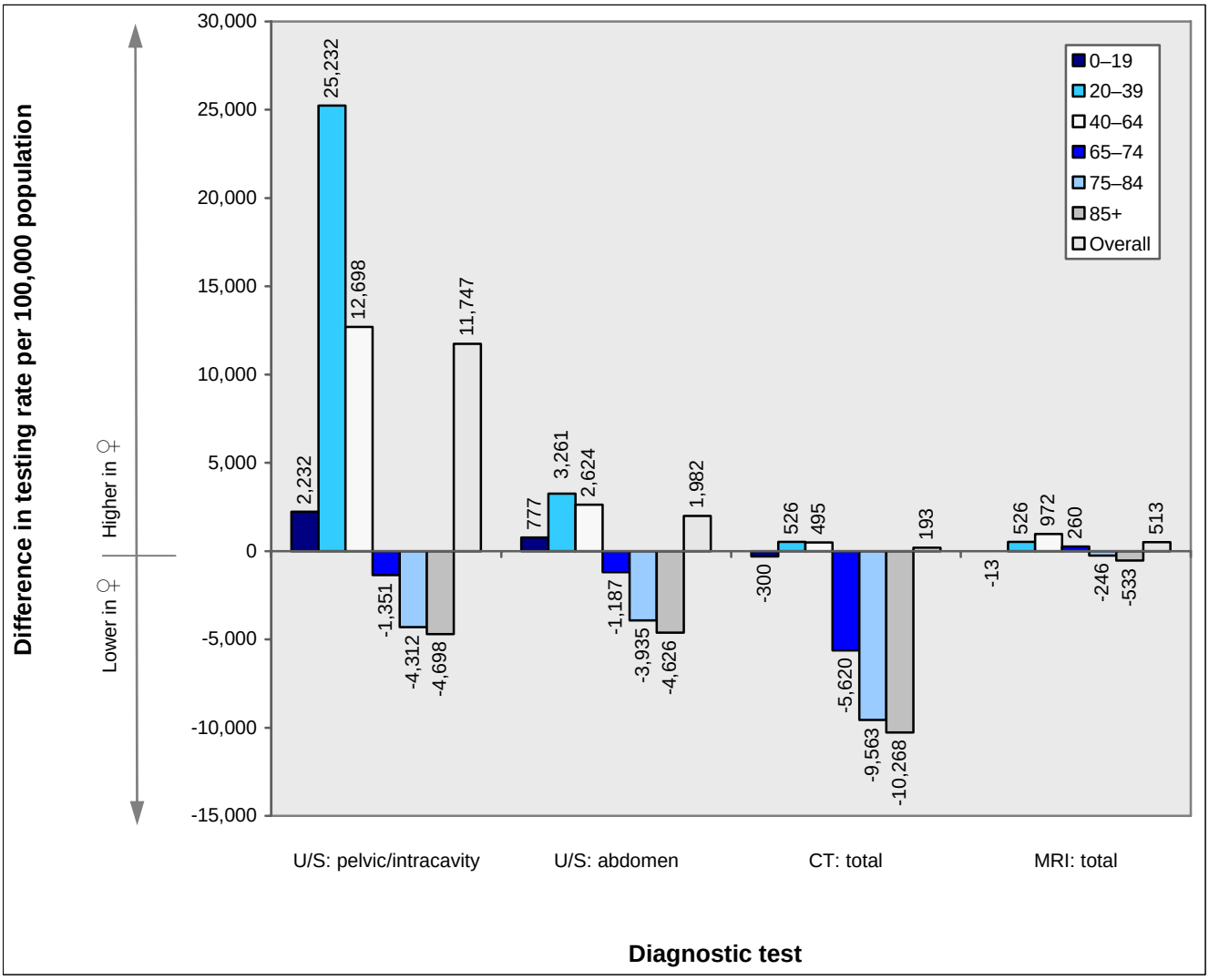
CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

For Exhibit 2.1

- In 2005/06, the highest testing rates were seen in resting ECGs (22,819 per 100,000 population), chest X-rays (15,635 per 100,000 population), pregnancy ultrasound (13,577 per 100,000 women aged 15-54 years), and CT scans (10,687 per 100,000 population).

Demographics

Exhibit 2.2a Difference in testing rate* per 100,000 population for selected diagnostic tests (CT, MRI, U/S), in women compared to men, by age group, in Ontario, 2005/06



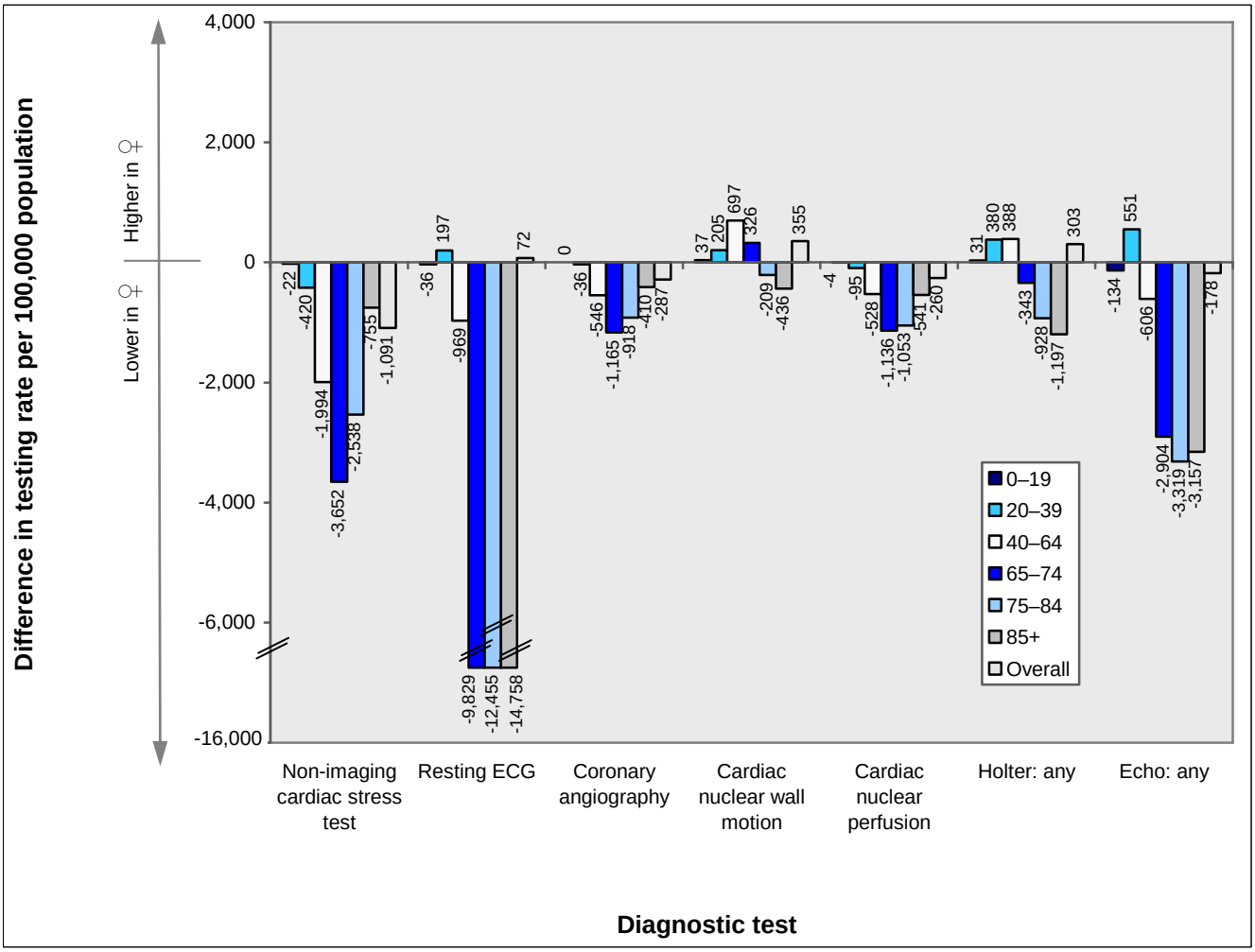
CT = Computed tomography; MRI = Magnetic resonance imaging; U/S = Ultrasound; ♀ = Women.

* Values on the y-axis which are above zero imply that the testing rate was higher in women than in men, while the converse is true for values below zero. For example, women aged 85 years and older had 4,626 (per 100,000 population) fewer abdominal ultrasounds than men in this age group.

For Exhibits 2.2a–c

- With few exceptions, testing rates were relatively higher among seniors (ages 65 and older) than among younger age groups.
- For most investigations, utilization rates in men exceeded those in women. Exceptions included pelvic and abdominal ultrasound tests and spinal X-rays.

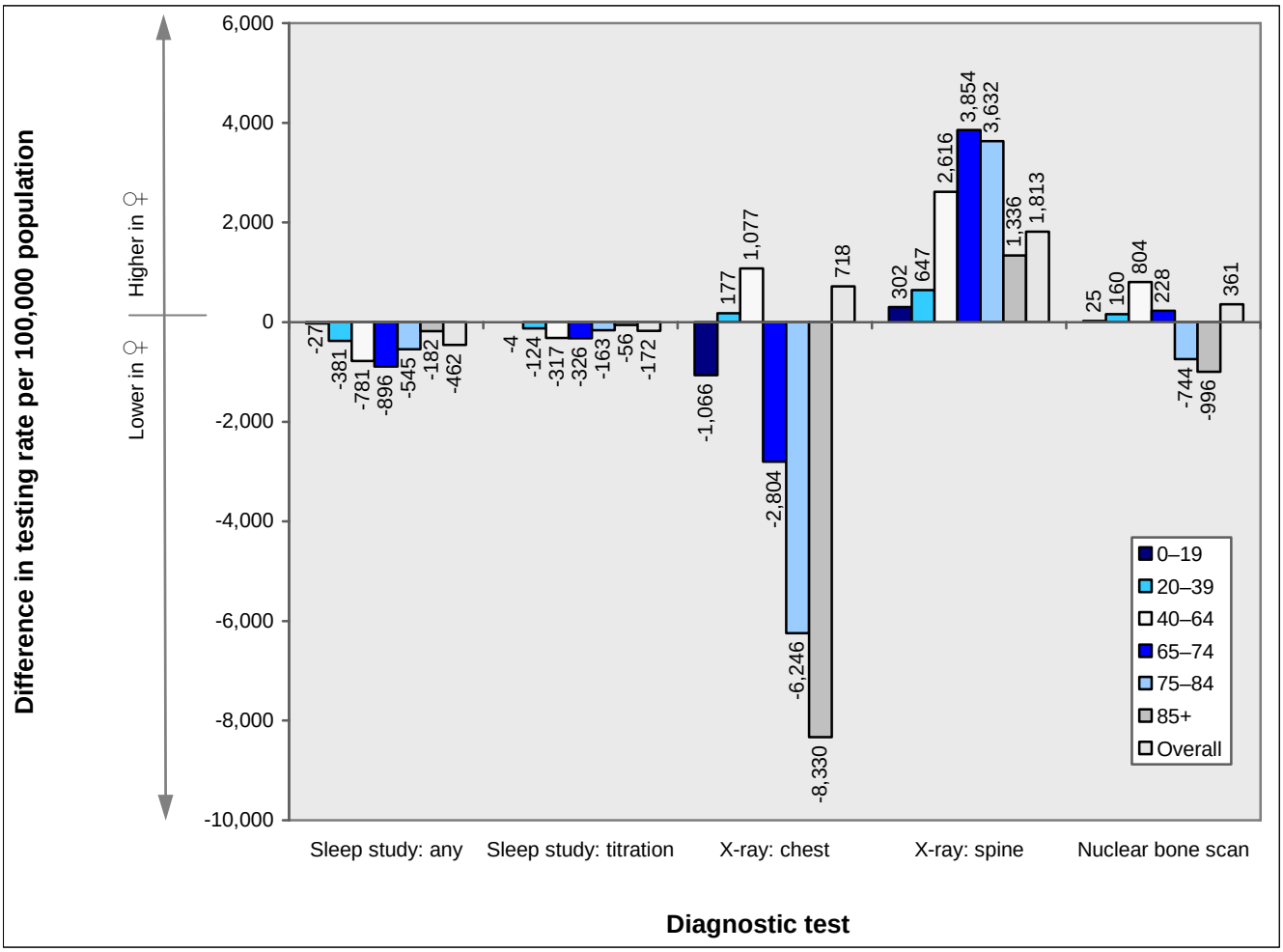
Exhibit 2.2b Difference in testing rate* per 100,000 population for selected diagnostic tests (cardiac investigations), in women compared to men, by age group, in Ontario, 2005/06



ECG = Electrocardiogram; Echo = Echocardiography; ♀ = Women.

* Values on the y-axis which are above zero imply that the testing rate was higher in women than in men, while the converse is true for values below zero. For example, women aged 65–74 years had 9,829 (per 100,000 population) fewer resting ECGs than men in this age group.

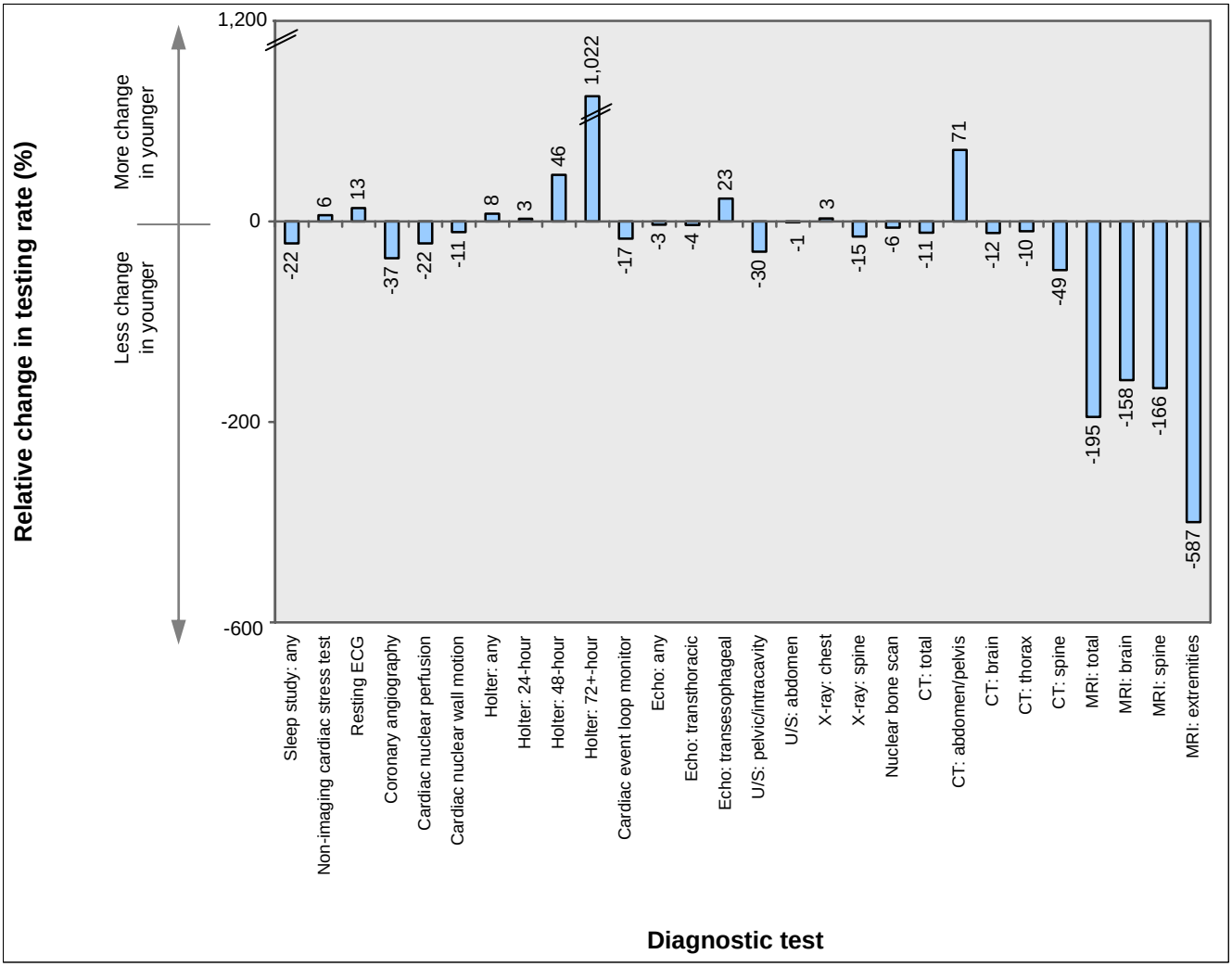
Exhibit 2.2c Difference in testing rate* per 100,000 population for selected diagnostic tests (sleep study, chest X-ray, spine X-ray, nuclear bone scan), in women compared to men, by age group, in Ontario, 2005/06



♀ = Women.

*****Values on the y-axis which are above zero imply that the testing rate was higher in women than men, while the converse is true for values below zero. For example, women aged 75–84 years have 6,246 (per 100,000 population) fewer chest X-rays than men in this age group.

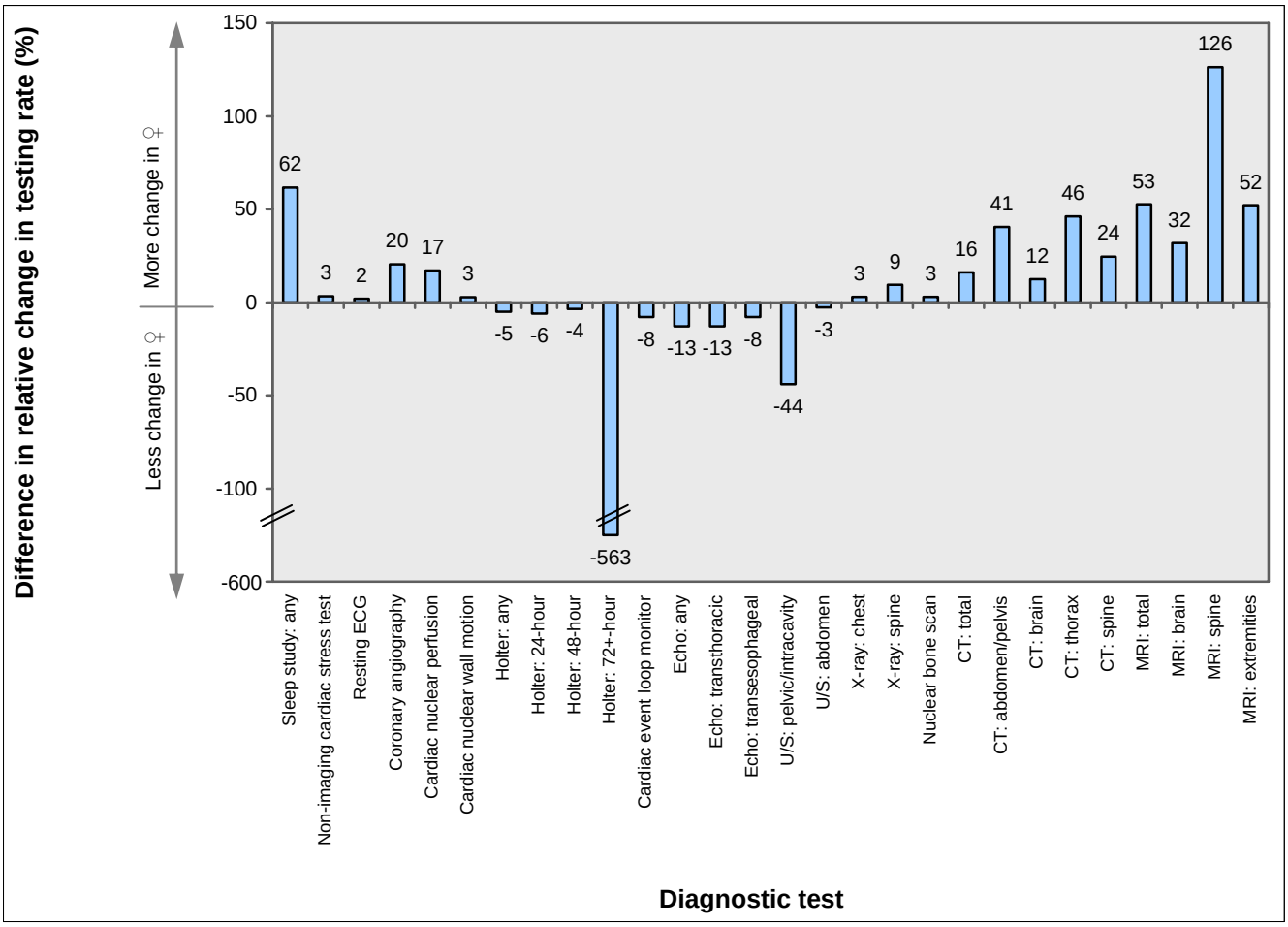
Exhibit 2.3 Difference in relative change* (%) over time in age-/sex-standardized testing rates per 100,000 population for selected diagnostic tests, in younger (aged under 65 years) compared to older (aged 65 years and older) patients, in Ontario, 1996/97 to 2005/06



CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

*****Values on the y-axis which are above zero imply that the testing rates over the past decade increased more for younger patients (aged under 65 years) than older patients (ages 65 years and older), while the converse is true for values below zero. For example, between 1996 and 2006, 72+-hour Holter monitoring increased 1,022% more among younger as compared to older patients, while MRI of the extremities increased 587% more among older as compared to younger patients.

Exhibit 2.4 Difference in the relative change* (%) over time in age-/sex-standardized testing rate per 100,000 population for selected diagnostic tests, in women compared to men, in Ontario, 1996/97 to 2005/06



CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound; ♀ = Women.

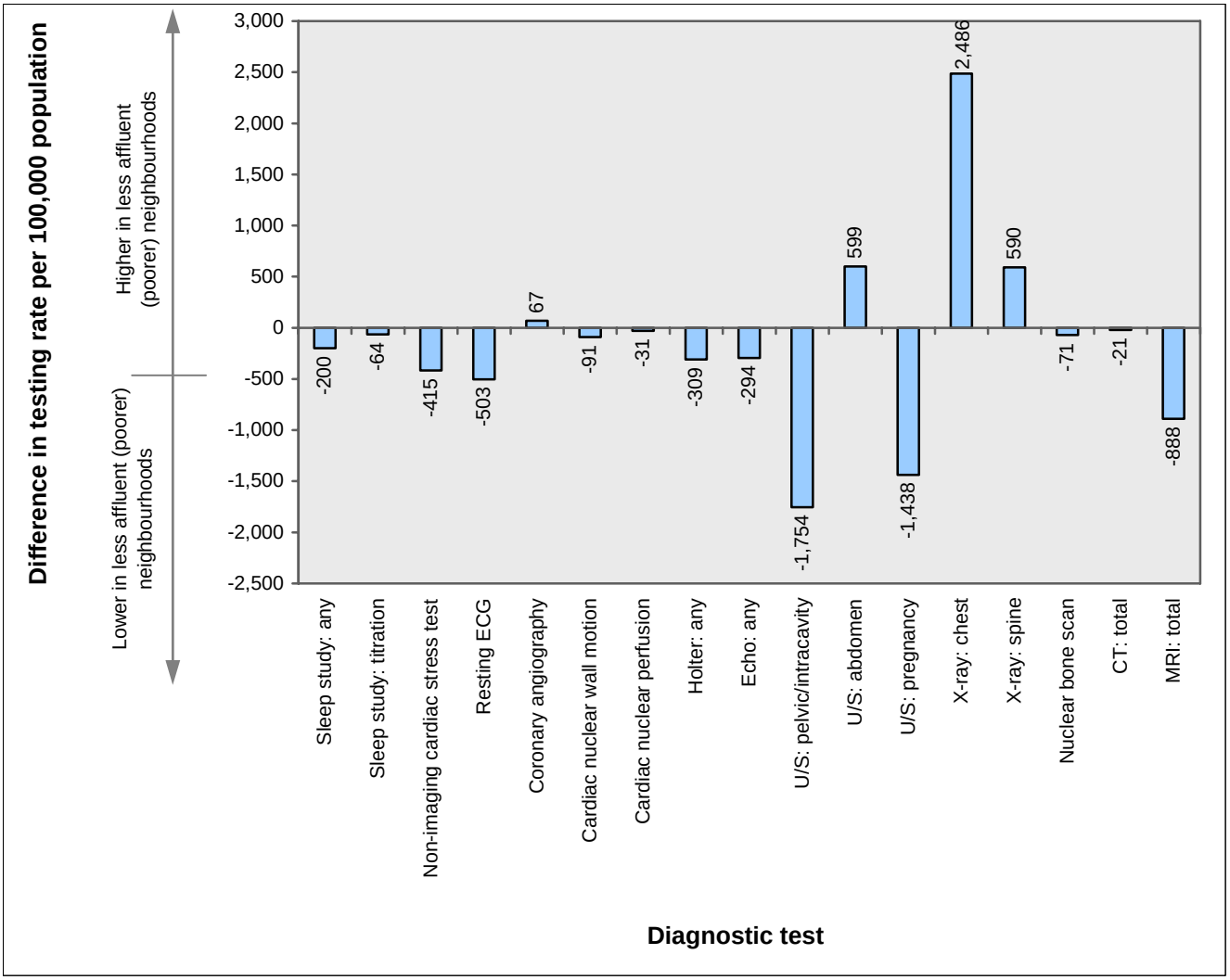
*Values on the y-axis which are above zero imply that the testing rates over the past decade increased more for females than for males, while the converse is true for values below zero. For example, sleep studies increased 62% more among women than among men, while 72+-hour Holter monitoring increased 563% more among men than among women.

For Exhibits 2.3–2.4

- There were only modest changes in the demographic characteristics of patients receiving diagnostic tests from 1996/97 to 2005/06.
- Demographic changes in test utilization were most pronounced for 72+-hour Holter monitoring and MRI. Rates of Holter monitoring increased more among men and persons under age 65 years, whereas rates of MRI grew relatively more among women and persons under age 65.

Socioeconomic status

Exhibit 2.5 Difference* in age- and sex-adjusted testing rate per 100,000 population for selected diagnostic tests, in the lowest compared to the highest neighbourhood income quintile**, in Ontario, 2005/06



CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

*Values on the y-axis which are above zero imply that the testing rates among poorer neighbourhoods (lowest neighbourhood income quintile) were higher than among the affluent (highest neighbourhood income quintile) neighbourhoods, while the converse is true for values less than zero. For example, the rate of chest X-rays was 2,486 per 100,000 population higher in poorer neighbourhoods, whereas the rate of pelvic/intracavity ultrasounds was 1,754 per 100,000 lower in poorer neighbourhoods.

**Neighbourhood income quintile is a measure of overall socioeconomic status. See Appendix A for details on how neighbourhood income quintile was calculated.

For Exhibit 2.5

- The magnitude of age- and sex-adjusted socioeconomic differences was substantially smaller than age-specific gender differences, suggesting that most variation in testing rates was explained by age and sex.
- For most of the tests we studied, rates of testing were relatively higher among patients residing in more affluent neighbourhoods. We would expect the opposite based on relatively greater disease burden in lower-income neighbourhoods. However, only four of 17 tests – chest X-ray, spine X-ray, abdominal ultrasound, and coronary angiography – had relatively higher rates in lower-income neighbourhoods.

Discussion

With the exception of CT scans, tests whose relative rates proliferated most markedly from 1996/97 to 2005/06 were not necessarily those which comprised the majority of the overall diagnostic test volumes in Ontario. The reasons for the age-related gender disparities are unclear but may be attributable in part to sex differences in life-expectancy (favouring women), disease onset, illness severity and comorbidity burden. The age/gender interaction in health service utilization has been previously described for cardiac health services in Ontario.[22]

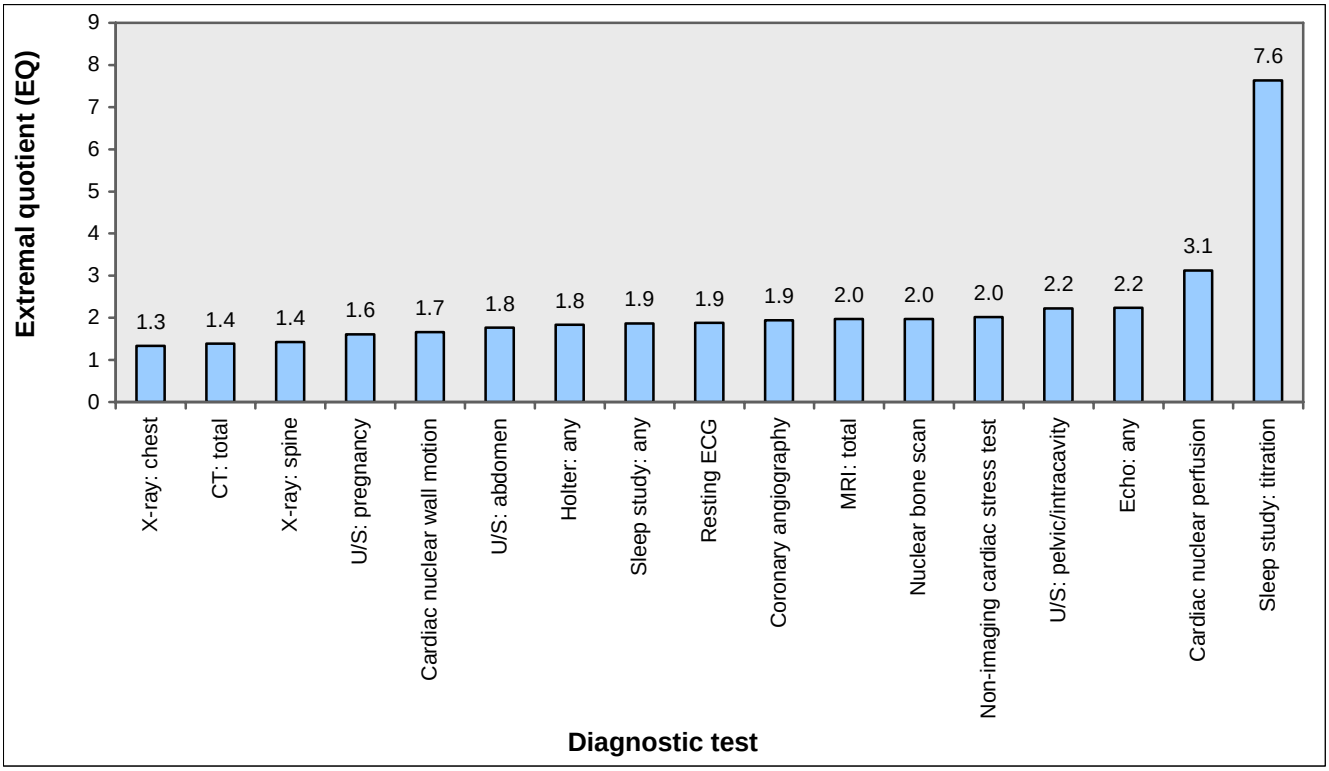
The reason for socioeconomic utilization disparities in testing rates is unknown, but may relate to differences in clinical factors, health-seeking behaviour, provider/referral thresholds and/or geographical access barriers.

Chapter 3: Regional Variation Across Local Health Integration Networks

This chapter describes the use of diagnostic testing across Local Health Integration Networks (LHINs) in Ontario. Overall regional variations in diagnostic testing are examined, with attention to those regions that differed significantly from the Ontario average. Finally, this chapter examines trends in regional variation of diagnostic testing over time.

Overall trends

Exhibit 3.1 Geographic variation in age- and sex-adjusted diagnostic testing rate per 100,000 population (expressed as the extremal quotient*) for selected diagnostic tests, across Local Health Integration Networks (LHINs), in Ontario, 2005/06



CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

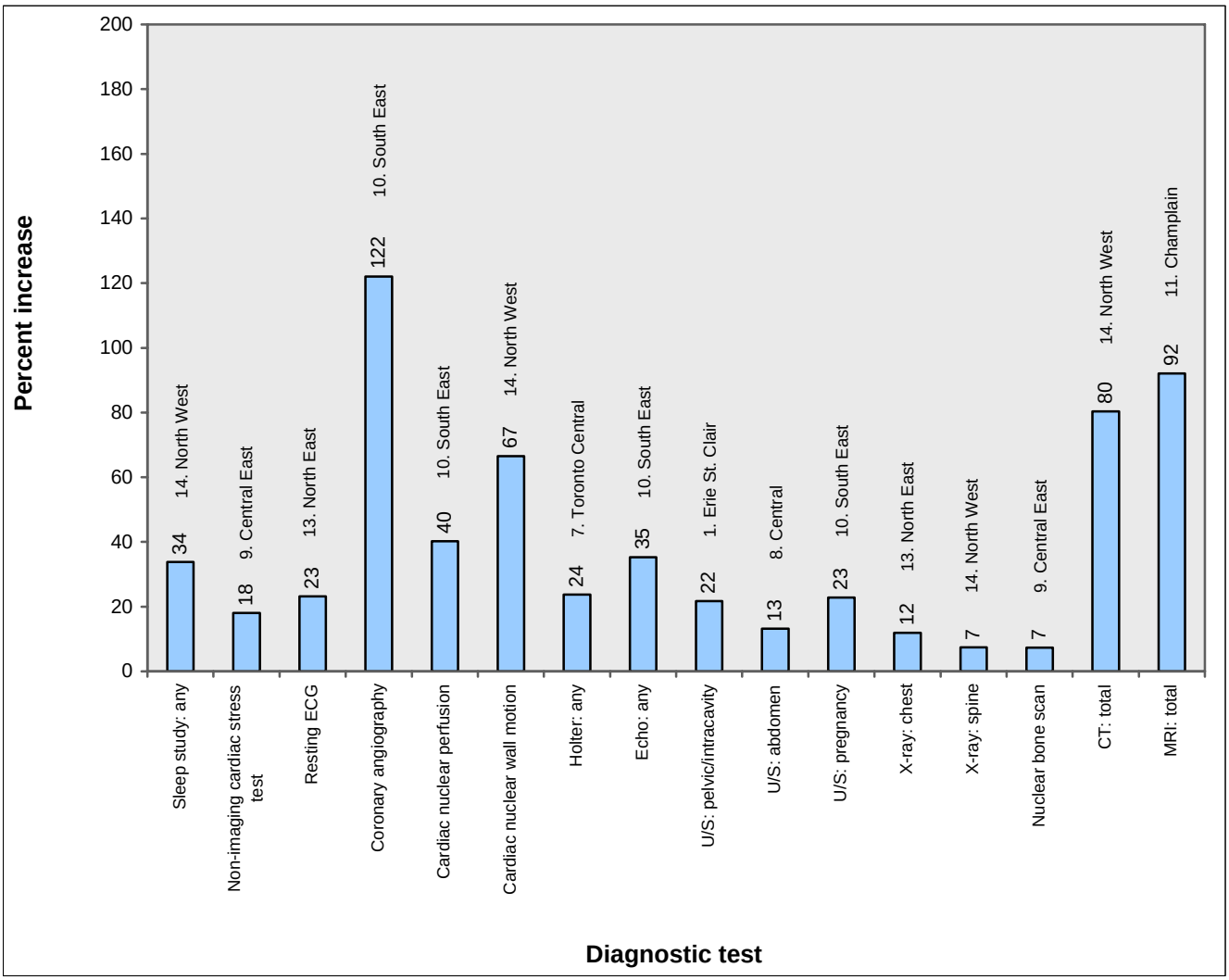
*Extremal quotient (EQ) refers to the relative difference between the highest and lowest age- and sex-adjusted diagnostic test rate. For example, there was a 3.1-fold difference between the highest rate and the lowest rate of cardiac nuclear perfusion testing across LHINs.

For Exhibit 3.1

- The Extremal Quotient (EQ - relative difference between the highest and lowest age- and sex-adjusted diagnostic test rate) was used to illustrate the regional variation in rates.
- Regional variation was marked for some tests and modest for others. Regional variation was most pronounced for sleep titration tests (EQ of 7.6) and cardiac nuclear perfusion tests (EQ of 3.1), while intermediate for echocardiography and pelvic/intracavity ultrasound (EQ of 2.2). Regional variations were least pronounced for chest and spinal X-rays and CT scans (EQ of 1.4 or less).

Temporal trends

Exhibit 3.2 Ontario Local Health Integration Networks (LHINs) with the greatest increase (%) in age- and sex-adjusted testing rate per 100,000 population for selected diagnostic tests, 2003/04 to 2005/06



LHINs

1. Erie St. Clair
2. South West
3. Waterloo Wellington
4. Hamilton Niagara Haldimand Brant
5. Central West
6. Mississauga Halton
7. Toronto Central
8. Central
9. Central East
10. South East
11. Champlain
12. North Simcoe Muskoka
13. North East
14. North West

CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

For Exhibit 3.2

- The South East LHIN and North West LHIN experienced the greatest growth in diagnostic testing during the three-year study period. In the South East LHIN, coronary angiography, cardiac nuclear perfusion, echocardiography, and pregnancy ultrasounds increased by 122%, 40%, 35%, and 23%, respectively.
- In the North West LHIN, sleep studies, nuclear wall motion tests, spine X-rays, and CT scans increased by 34%, 67%, 7%, and 80%, respectively.
- The Champlain LHIN had the greatest growth in MRI (92%), while the Central East LHIN had the greatest growth in stress tests (18%) and nuclear bone scans (7%).

Ranks and outliers

Exhibit 3.3a Age- and sex-adjusted rate of diagnostic testing per 100,000 population for selected diagnostic tests (cardiac investigations) and rank*, by Local Health Integration Network (LHIN), in Ontario, 2005/06

LHIN	Rate per 100,000 population (rank)					
	Non-imaging cardiac stress test	Resting ECG	Coronary angiography	Cardiac nuclear perfusion	Cardiac nuclear wall motion	Holter: any
1. Erie St. Clair	2,587 (6)	17,901 (10)	413 (9)	883 (9)	948 (4)	1,639 (5)
2. South West	1,857 (12)	15,566 (14)	322 (13)	542 (14)	890 (6)	1,302 (11)
3. Waterloo Wellington	1,886 (11)	18,019 (9)	318 (14)	674 (11)	714 (14)	1,298 (12)
4. Hamilton Niagara Haldimand Brant	2,210 (8)	20,342 (6)	461 (5)	1,020 (7)	785 (10)	1,539 (6)
5. Central West	2,846 (3)	26,608 (2)	455 (6)	1,693 (1)	1,007 (2)	1,689 (4)
6. Mississauga Oakville	2,473 (7)	25,935 (3)	393 (10)	1,577 (2)	755 (12)	1,525 (7)
7. Toronto Central	2,166 (10)	24,622 (5)	367 (12)	1,381 (5)	960 (3)	1,489 (9)
8. Central	2,778 (5)	29,241 (1)	413 (8)	1,539 (3)	865 (8)	1,829 (3)
9. Central East	3,247 (1)	25,114 (4)	473 (4)	1,415 (4)	1,188 (1)	1,880 (1)
10. South East	2,180 (9)	16,246 (13)	499 (3)	656 (12)	760 (11)	1,315 (10)
11. Champlain	1,639 (13)	19,292 (7)	381 (11)	1,034 (6)	741 (13)	1,024 (14)
12. North Simcoe Muskoka	1,613 (14)	17,790 (11)	435 (7)	565 (13)	877 (7)	1,284 (13)
13. North East	2,821 (4)	17,422 (12)	569 (2)	953 (8)	858 (9)	1,863 (2)
14. North West	2,919 (2)	18,918 (8)	616 (1)	867 (10)	922 (5)	1,517 (8)

ECG = Electrocardiogram.

*Rank (1) is the LHIN with the highest rate while rank (14) is the lowest. For example, for cardiac investigations, the Central West and Central East LHINs had higher rates than other regions, while the South West, Waterloo Wellington, South East and North Simcoe Muskoka LHINs had lower rates.

For Exhibits 3.3a–c

- Rankings of diagnostic testing rates by LHIN were dependent upon the particular diagnostic test examined, and no LHIN was consistently ranked as a high or low outlier for any of the selected diagnostic tests. Nonetheless, for some tests, rankings did correlate across LHINs (e.g., echocardiography [ECG] and cardiac nuclear perfusion imaging). Testing rates in the South West LHIN (and to a lesser extent, in the Waterloo Wellington and South East LHINs) tended to be ranked lower than elsewhere in the province, while the converse was generally true for the Central LHIN and the Central East LHIN. For other LHINs, rankings varied markedly across tests. For example, the North West was ranked highest for chest X-rays, coronary angiography, and MRI and lowest for sleep studies and nuclear bone scans.
- The following points highlight regional variations for selected tests in 2005/06:

  MRI: The highest age- and sex-adjusted rates for MRI occurred in the North West, Hamilton Niagara Haldimand Brant and Toronto Central LHINs (3,637, 2,944 and 2,817 per 100,000 population, respectively). The lowest age- and sex-adjusted rates for MRI occurred in the Waterloo Wellington, Erie St. Clair and South West LHINs (1,846, 1,897 and 1,978 per 100,000 population, respectively).

  CT: The highest age- and sex-adjusted rates for CT occurred in the North Simcoe Muskoka, Champlain and Central East LHINs (12,838, 11,115 and 11,085 per 100,000 population, respectively). The lowest age- and sex-adjusted rates for CT occurred in the Waterloo Wellington, Hamilton Niagara Haldimand Brant and South West LHINs (9,234, 9,364 and 9,511 per 100,000 population, respectively). The correlation in age- and sex-adjusted rates between CT and MRI was poor (r=0.29).

  Sleep studies: The highest age- and sex-adjusted rates for sleep studies occurred in the South East, Central East and Mississauga Oakville LHINs (974, 953 and 926 per 100,000 population, respectively). The lowest age- and sex-adjusted rates for sleep studies occurred in the North West, Central West and North Simcoe Muskoka LHINs (522, 681, and 689 per 100,000 population, respectively).

For Exhibits 3.3a–c (continued)

Cardiac nuclear perfusion tests: The highest age- and sex-adjusted rates for cardiac nuclear perfusion tests occurred in the Central West, Mississauga Oakville and Central LHINs (1,693, 1,577 and 1,539 per 100,000 population, respectively). The lowest age- and sex-adjusted rates for cardiac nuclear perfusion tests occurred in the South West, North Simcoe Muskoka and South East LHINs (542, 565 and 656 per 100,000 population respectively). The regional rankings for cardiac nuclear perfusion imaging correlated strongly with echocardiography (r=0.78), but weakly with cardiac nuclear wall motion studies (r=0.26).

Other tests: While variations for continuous ambulatory ECG monitoring (i.e., Holter) were intermediate (extremal quotient**=1.8), there were marked regional variations in continuous ambulatory ECG monitoring over extended periods of time. For example, the Extremal Quotients (EQs) for 48-hour Holters, 72+-hour Holters, and cardiac event loop monitors were 3.6, 11.6, and 60.4, respectively (data not shown). The reason for such regional differences in the use of Holter monitoring and cardiac event loop monitors over longer periods of time is not clear, especially given that ambulatory laboratories, which provide 24-hour Holter monitoring, usually have the capability of providing Holter monitoring over extended intervals. Regional variations were more marked for transesophageal echocardiography (EQ=4.0) than for transthoracic echocardiography (EQ=2.2). This finding is likely explained by the fact relatively few cardiologists perform transesophageal echocardiograms.

Exhibit 3.3b Age- and sex-adjusted rate of diagnostic testing per 100,000 population for selected diagnostic tests (CT, MRI, U/S) and rank*, by Local Health Integration Network (LHIN), in Ontario, 2005/06

LHIN	Rate per 100,000 population (rank)					
	Echo: any	U/S: abdomen	U/S: pregnancy	U/S: pelvic/intracavity	CT: total	MRI: total
1. Erie St. Clair	3,490 (8)	6,139 (8)	11,292 (12)	6,749 (12)	10,162 (8)	1,897 (13)
2. South West	2,519 (14)	5,310 (13)	11,292 (13)	7,133 (9)	9,511 (12)	1,978 (12)
3. Waterloo Wellington	3,138 (11)	5,897 (10)	14,290 (6)	7,487 (6)	9,234 (14)	1,846 (14)
4. Hamilton Niagara Haldimand Brant	3,727 (7)	6,030 (9)	13,733 (8)	6,869 (11)	9,364 (13)	2,944 (2)
5. Central West	4,779 (3)	8,005 (3)	16,470 (1)	11,592 (3)	9,656 (11)	2,125 (10)
6. Mississauga Oakville	4,116 (5)	7,183 (5)	14,416 (5)	10,802 (4)	9,933 (10)	2,478 (7)
7. Toronto Central	4,686 (4)	8,209 (2)	14,730 (4)	12,677 (1)	10,702 (7)	2,817 (3)
8. Central	5,643 (1)	9,231 (1)	15,003 (3)	12,666 (2)	10,747 (5)	2,606 (6)
9. Central East	5,552 (2)	7,706 (4)	13,949 (7)	9,632 (5)	10,999 (4)	2,418 (8)
10. South East	3,337 (9)	5,234 (14)	13,497 (9)	5,698 (14)	10,709 (6)	2,085 (11)
11. Champlain	2,648 (13)	5,478 (12)	15,232 (2)	7,163 (8)	11,085 (3)	2,735 (5)
12. North Simcoe Muskoka	3,214 (10)	5,512 (11)	12,040 (11)	7,261 (7)	12,838 (1)	2,376 (9)
13. North East	3,852 (6)	6,722 (6)	10,241 (14)	6,272 (13)	10,021 (9)	2,763 (4)
14. North West	2,915 (12)	6,162 (7)	12,861 (10)	6,922 (10)	11,115 (2)	3,637 (1)

CT= Computed tomography; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

*Rank (1) is the LHIN with the highest rate while rank (14) is the lowest. For example, for ultrasound, CT, and MRI, the Toronto Central and Central LHINs had higher rates than other regions, while the Erie St. Clair, South West and South East LHINs had lower rates.

** Extremal quotient (EQ) refers to the relative difference between highest and lowest test rates.

Exhibit 3.3c Age- and sex-adjusted rate of diagnostic testing per 100,000 population for selected diagnostic tests (sleep study, chest X-ray, spine X-ray, nuclear bone scan) and rank*, by Local Health Integration Network (LHIN), in Ontario, 2005/06

LHIN	Rate per 100,000 population (rank)			
	Sleep study: any	X-ray: chest	X-ray: spine	Nuclear bone scan
1. Erie St. Clair	729 (10)	16,503 (2)	6,006 (1)	1,270 (1)
2. South West	694 (11)	13,661 (13)	4,602 (13)	909 (9)
3. Waterloo Wellington	880 (6)	12,925 (14)	4,219 (14)	853 (10)
4. Hamilton Niagara Haldimand Brant	774 (9)	15,557 (5)	5,456 (5)	839 (11)
5. Central West	681 (13)	15,326 (7)	5,577 (3)	1,051 (5)
6. Mississauga Oakville	926 (3)	14,966 (11)	5,027 (9)	919 (8)
7. Toronto Central	799 (8)	15,271 (8)	4,744 (11)	960 (7)
8. Central	848 (7)	15,904 (3)	5,267 (7)	1,051 (4)
9. Central East	953 (2)	15,622 (4)	5,408 (6)	1,219 (2)
10. South East	974 (1)	14,424 (12)	4,770 (10)	729 (13)
11. Champlain	900 (5)	15,061 (9)	5,154 (8)	819 (12)
12. North Simcoe Muskoka	689 (12)	15,005 (10)	4,691 (12)	1,092 (3)
13. North East	921 (4)	15,492 (6)	5,689 (2)	1,037 (6)
14. North West	522 (14)	17,253 (1)	5,517 (4)	644 (14)

*Rank (1) is the LHIN with the highest rate while rank (14) is the lowest. For example, the North West LHIN had the highest rate of chest X-rays, while the Waterloo Wellington LHIN had the lowest rate.

Discussion

The magnitudes of regional variation seen for diagnostic testing were similar to those reported for many surgeries performed in Ontario during the fiscal year 2004/05.[23] For example, EQs for large bowel resections, bypass surgeries, total knee replacements and mastectomies were 1.5, 1.9, 2.2 and 2.9, respectively. Health service variations may be attributable to a variety of factors including: differences in illness severity, clinical necessity and appropriateness, variations in health-seeking behaviours and physician decision-making, and disparities in access to services. As an example of disparities in access to services, regional differences in the use of coronary angiography have been shown to be attributable to variations in the supply of cardiac catheterization labs.[24,25]

One might hypothesize that differences in the distribution and characteristics of physicians in a given region (specialty vs. primary care, gender, training) may account for regional variations in the use of diagnostic imaging services.[26] For example, the high correlation between nuclear perfusion imaging and echocardiography may relate to the fact that echocardiography serves as a surrogate for cardiac physician supply—given that echocardiography is often available and provided by cardiologists in ambulatory settings. It is possible that physicians practicing in regions with fewer cardiologists (and therefore fewer echocardiograms) may refer their patients preferentially for wall motion studies (which are often available within hospitals or independent health facilities). Indeed, the correlation between wall motion studies and echocardiography is poor. Other studies have demonstrated that regional variations in testing increase where appropriateness is most uncertain and referral decisions are discretionary.[27]

Our results confirm the existence of regional differences in the use of diagnostic imaging services, with magnitudes generally in line with differences reported for other therapeutic interventions. It cannot be determined whether high-rate regions perform too many tests, low-rate regions perform too few tests, or each region performs an appropriate number of tests based on disease prevalence and clinical necessity.

Chapter 4: Substitution of One Test for Another

Where two tests may provide similar information, a physician may order either or both. Nuclear wall motion and echocardiography served as a test case to examine substitution of one test for another.

Exhibit 4.1 Annual number of patients having cardiac nuclear wall motion and/or echocardiography diagnostic tests, in Ontario, 1996/97 to 2005/06

Fiscal Year	Diagnostic test (number of patients tested)		
	Only cardiac nuclear wall motion	Only echocardiography*	Both cardiac nuclear wall motion and echocardiography*
1996/97	82,300	217,842	8,631
1997/98	87,125	256,303	9,981
1998/99	83,897	268,019	9,840
1999/00	83,150	286,629	9,777
2000/01	83,519	310,198	10,398
2001/02	85,149	330,590	10,382
2002/03	86,302	355,871	11,337
2003/04	85,612	369,947	11,829
2004/05	89,835	408,428	13,624
2005/06	91,803	450,193	15,156

* Any echocardiography, including transthoracic and transesophageal.

For Exhibit 4.1

- The prevalence of patients receiving both wall motion studies and echocardiography within a year increased over time (1996/97–2005/06) to a similar degree as those receiving either echocardiography alone, or wall motion studies alone.
- Only 10% and 17% of patients who received a wall motion test in 1996/97 and 2005/06, respectively, also received an echocardiogram within the same fiscal year.

Discussion

There is little evidence of substitution effects, where newer technologies replace older ones. In the current study, utilization of echocardiography and wall motion studies served as a test case, and there was no clear evidence of substitution—the use of both tests rose at similar rates as did the use of either test alone. The overall proportion of patients having both tests was low, suggesting that there was little evidence of inappropriate redundant utilization of the two tests together.

Chapter 5: Repeat Testing

This chapter describes trends in repeat testing—when an individual has two or more of the same test within one year. Determination of repeat testing required each patient to have at least one of the study tests during 2004/05. We describe the prevalence of repeat testing in two ways: the percentage of patients who received one or more tests after the first; and the proportion of all tests that these repeats represent. For example, among women who had a pregnancy ultrasound test during 2004/05, 69.2% had one or more repeat ultrasound tests within one year of the first, and these repeated tests comprised 88.5% of all pregnancy ultrasound tests performed.

Overall trends

Exhibit 5.1 Repeat diagnostic testing: Percentage of patients receiving repeat tests, and percentage of all tests that were repeated, within one year, in Ontario, 2004/05

	Level of Analysis and Test Frequency							
	Patient Level				Test Level			
Diagnostic Test	No Repeats	1 Repeat	2 Repeats	≥ 3 Repeats	No Repeats	1 Repeat	2 Repeats	≥ 3 Repeats
Non-imaging cardiac stress test	81.9	15.5	2.1	0.4	67.6	25.7	5.2	1.5
Resting ECG	63.2	22.8	7.9	6.2	38.5	27.8	14.4	19.3
Coronary angiography	90.7	8.0	1.1	0.2	81.8	14.5	2.9	0.8
Cardiac nuclear perfusion	86.6	12.3	0.7	0.3	75.4	21.4	1.9	1.2
Cardiac nuclear wall motion	91.0	7.4	1.1	0.5	81.7	13.3	3.0	2.1
Holter: any	81.7	14.2	2.6	1.4	65.7	22.9	6.4	5.0
Holter: 24-hour	87.3	10.3	1.8	0.7	75.1	17.6	4.7	2.6
Holter: 48-hour	88.7	9.1	1.8	0.4	77.9	15.9	4.8	1.3
Holter: 72-hour	88.7	8.5	1.7	1.1	76.4	14.7	4.3	4.7
Cardiac event loop monitor	86.6	10.6	1.9	0.9	73.6	17.9	5.0	3.5
Echo: any	81.4	15.1	2.6	0.9	65.9	24.5	6.4	3.2
Echo: transthoracic	81.5	15.2	2.5	0.7	66.4	24.7	6.1	2.7
Echo: transesophageal	95.3	4.2	0.4	0.1	90.5	8.0	1.2	0.3
U/S: pelvic/intracavity	69.4	19.7	6.0	4.9	41.1	23.4	10.6	25.0
U/S: abdomen	79.4	16.6	3.2	0.8	63.0	26.4	7.6	3.0
U/S: pregnancy	30.8	27.1	18.8	23.3	11.5	20.2	20.9	47.4
CT: total	53.8	25.5	6.6	14.1	25.0	23.8	9.2	42.0
CT: abdomen	70.0	17.6	6.7	5.7	45.6	22.9	13.2	18.3
CT: pelvis	71.9	16.7	6.2	5.2	48.0	22.4	12.5	17.1
CT: brain	82.7	12.0	3.0	2.2	64.8	18.9	7.1	9.2
CT: thorax	64.9	19.5	8.7	7.0	39.7	23.9	16.0	20.4
CT: spine	94.5	4.9	0.5	0.2	88.8	9.3	1.3	0.6
MRI: total	80.0	15.3	3.0	1.7	62.7	24.0	7.0	6.2
MRI: brain	85.2	11.1	2.3	1.4	70.6	18.4	5.7	5.2
MRI: spine	87.7	10.3	1.6	0.4	76.5	18.0	4.1	1.4
MRI: extremities	91.2	8.0	0.7	0.1	83.0	14.5	1.9	0.6
Sleep study: any	68.4	28.3	2.7	0.5	50.5	41.8	6.1	1.6
Sleep study: titration	95.4	4.5	0.1	-	91.1	8.7	0.2	-
X-ray: chest	69.2	19.9	6.3	4.6	45.5	26.2	12.4	15.9
X-ray: spine	85.5	12.1	1.8	0.6	72.6	20.5	4.5	2.4
Nuclear bone scan	90.3	8.2	1.2	0.3	80.8	14.7	3.2	1.2

CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

Note: Determination of repeat testing was not site-specific. For example, three repeated CT scans could have been performed for three different anatomical sites (e.g., abdomen, pelvis, and brain).

For Exhibit 5.1

- The average prevalence of repeat testing (i.e., two or more tests within one year) was 20% of patients and 36% of tests. For most tests, the prevalence of repeat testing within one year ranged from 10% to 30% of patients and 20% to 40% of tests.
- Repeat testing was most pronounced for ultrasounds in pregnancy. Given that repeats were defined as a second test within one year of the first test, it could not be definitively determined whether all repeat ultrasounds pertained to the same pregnancy. Indeed, it is possible that a patient who had an ultrasound early in the year and in the latter stages of one pregnancy (i.e., third trimester), may have had a second ultrasound within one year related to a second pregnancy. Other patients may have had multiple spontaneous miscarriages. Nonetheless, if one assumes only one pregnancy per year, 69% of patients received a minimum of two ultrasounds during pregnancy and 42% of patients received three or more ultrasounds during pregnancy between 2004/05 and 2005/06.
- Electrocardiograms (ECGs) and thoracic CT scans also were associated with high rates of repeat testing. Thirty-seven percent of patients had multiple ECGs within one year, and repeat tests comprised 61.5% of all ECGs. Similarly, 35% of patients had multiple thoracic CT scans within one year, and the repeats comprised 60.3% of all tests.
- Sleep studies were associated with a high frequency of a single repeat test (28.3% of patients and 41.8% of tests, respectively), but the frequency of two or more repeats within one year was low (3.3% and 7.7% of patients and tests, respectively).
- Prevalence of one or more repeated tests was least pronounced for sleep titration tests (4.6% of patients, 8.9% of tests), transesophageal echocardiography (4.7% of patients, 9.5% of tests), spinal CT (5.5% of patients, 11.2% of tests), cardiac nuclear wall motion tests (9.0% of patients, 18.3% of tests), and nuclear bone scans (9.7% of patients, 19.2% of tests).

Temporal trends

Exhibit 5.2 Relative change* (%) in repeat diagnostic testing: Percentage of patients receiving repeat tests, and percentage of tests that were repeated, within one year, in Ontario, 2004/05 vs. 1996/97

	Level of Analysis and Percent Change							
	Patient Level				Test Level			
Diagnostic Test	No Repeats	1 Repeat	2 Repeats	≥ 3 Repeats	No Repeats	1 Repeat	2 Repeats	≥ 3 Repeats
Non-imaging cardiac stress test	1.4	-4.6	-14.3	-9.8	2.8	-3.3	-13.2	-8.7
Resting ECG	-1.3	1.3	3.9	3.9	-2.4	0.2	2.7	2.7
Coronary angiography	0.9	-5.3	-17.8	-40.4	2.1	-4.2	-16.8	-38.2
Cardiac nuclear perfusion	-0.2	1.6	-14.4	62.6	-0.5	1.3	-14.7	57.2
Cardiac nuclear wall motion	-0.5	-0.7	28.8	109.6	-1.7	-2.0	27.2	110.3
Holter: any	4.2	-14.1	-14.3	-27.7	8.8	-10.2	-10.5	-28.1
Holter: 24-hour	3.0	-13.2	-26.2	-36.6	6.7	-10.1	-23.5	-34.1
Holter: 48-hour	0.3	9.2	-4.6	-72.6	2.6	11.8	-2.4	-73.3
Holter: 72+-hour	-5.7	74.3	544.9	43.7	-11.3	64.0	506.7	10.0
Cardiac event loop monitor	0.3	3.9	1.0	-43.2	5.8	9.6	6.5	-62.9
Echo: any	-3.5	16.1	31.6	41.6	-6.9	12.1	27.0	36.4
Echo: transthoracic	-3.6	15.9	35.7	53.4	-6.9	11.9	30.9	47.4
Echo: transesophageal	1.2	-26.8	-	16.1	1.9	-26.3	-	-6.5
U/S: pelvic/intracavity	-6.5	12.1	29.8	36.0	-12.7	4.7	21.2	13.9
U/S: abdomen	-2.8	13.6	12.1	-5.6	-4.7	11.3	9.9	-7.4
U/S: pregnancy	-29.6	-9.5	29.0	99.2	-45.7	-30.3	-0.6	64.3
CT: total	-23.6	46.0	34.7	94.4	-42.2	10.5	1.9	60.5
CT: abdomen	-5.3	11.3	16.0	25.8	-10.5	5.2	9.6	20.0
CT: pelvis	-1.5	3.5	0.7	11.4	-3.9	1.0	-1.8	13.0
CT: brain	-2.4	12.2	19.8	13.3	-4.9	9.4	16.8	7.8
CT: thorax	-14.2	24.1	68.5	93.9	-27.0	5.5	43.3	73.1
CT: spine	3.6	-37.4	-40.8	-1.6	7.1	-35.3	-38.8	-1.5
MRI: total	-5.7	27.1	46.9	60.9	-11.4	19.4	38.0	55.3
MRI: brain	-2.9	16.4	20.8	80.4	-6.8	11.8	16.0	85.9
MRI: spine	-3.1	28.5	40.4	28.1	-6.0	24.7	36.2	23.1
MRI: extremities	-2.4	44.0	-13.1	-38.6	-4.1	41.5	-14.6	-39.7
Sleep study: any	17.1	3.1	-70.8	-88.8	41.0	24.2	-64.8	-87.8
X-ray: chest	-2.1	3.9	9.3	5.0	-3.7	2.1	7.5	2.3
X-ray: spine	0.4	-1.4	-4.6	-14.4	1.0	-0.8	-4.1	-13.3
Nuclear bone scan	1.2	-9.5	-10.8	-10.7	2.3	-8.5	-9.8	-7.6

CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

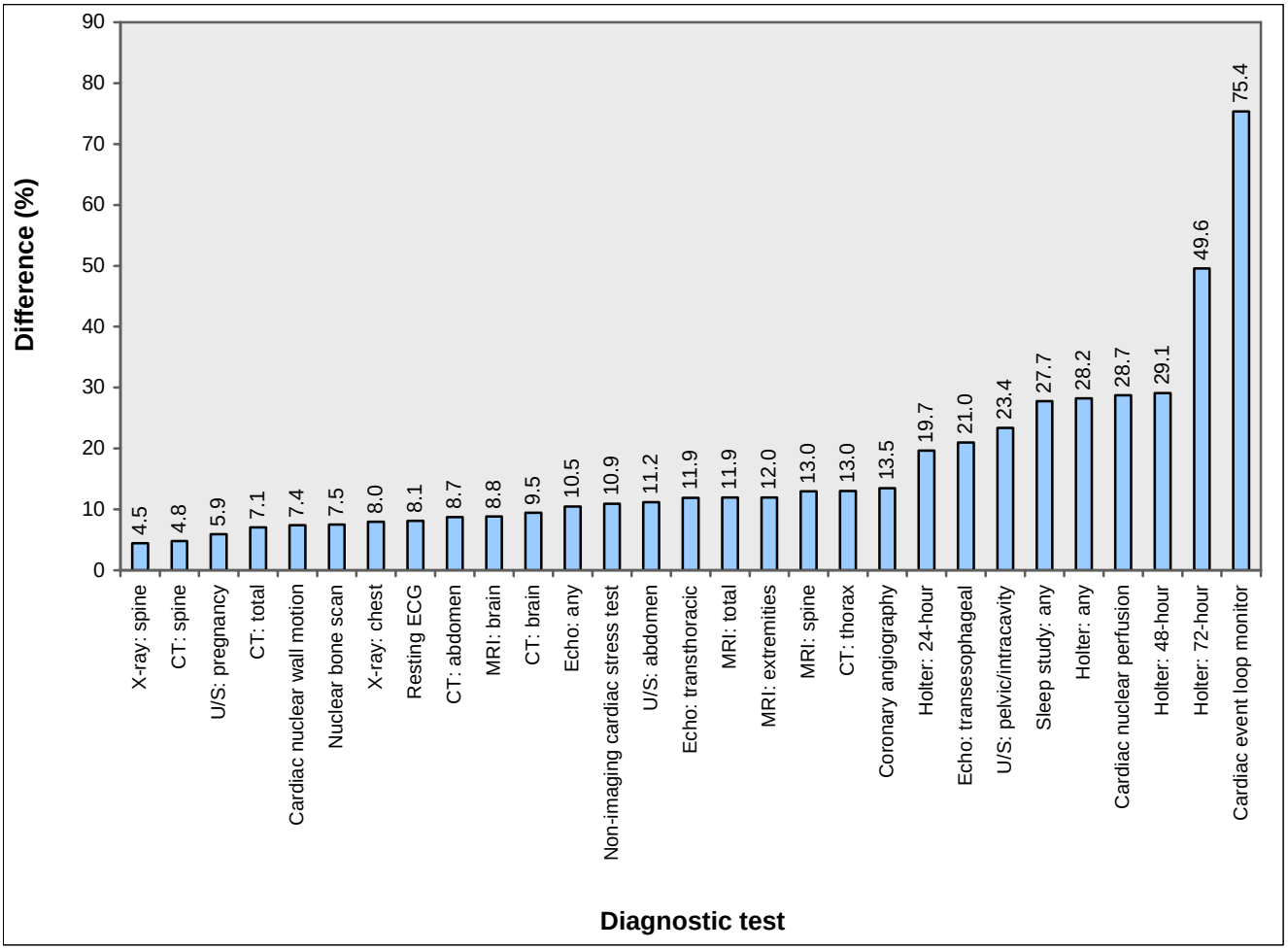
*Values above zero imply that there was relative growth over the study period, whereas values below zero imply a relative decline.

For Exhibits 5.2

- The prevalence of repeat testing rose over time for some tests and paradoxically fell for others.
- The prevalence of repeat testing rose for resting ECG, cardiac wall motion studies, 72+-hour Holter monitoring, echocardiography, ultrasound, CT, and MRI.
- While the prevalence of one repeat sleep study increased slightly over time, the frequency of multiple repeat sleep studies fell. This finding may be attributable to the emergence of billing codes for sleep titration studies in 2002/03. These tests evaluate the therapeutic response to sleep disorder interventions and would replace the need for repeating a generic sleep study in this population.

Geographic variation in repeat testing

Exhibit 5.3 Difference* across Ontario Local Health Integration Networks (LHINs) in the percentage of selected diagnostic tests repeated within one year, 2004/05



CT = Computed tomography; ECG = Electrocardiogram; Echo = Echocardiography; MRI = Magnetic resonance imaging; U/S = Ultrasound.

*Determined by subtracting the percentage of tests repeated in the LHIN with the lowest repeat testing rate from that in the LHIN with the highest repeat testing rate. For example, there was a 4.5% difference in the percentage of spine X-rays repeated within one year between the LHINs with the highest and lowest repeat testing rates.

For Exhibit 5.3

- The variation in repeat testing rates across LHINs ranged from 5% (for spine X-rays) to 75% (for cardiac event loop monitoring). However, for most tests, the magnitude of the variation in repeat testing was modest (ranging between 5% and 15%) across LHINs.

Discussion

Few studies, either within Canada or internationally, have explored the determinants of repeat diagnostic testing. While one could speculate that a physician's likelihood to refer a patient for multiple tests may mirror a physician's likelihood to refer a patient for any single tests, this may not be the case. Indeed, repeat testing may be more appropriate in patients who require close attention, surveillance and follow-up, due to illness severity alone. Therefore, information related to clinical severity, referral indications and test results is necessary to better understand and interpret the significance of repeat testing. While the prevalence of annual repeats for most tests ranged between 20–40%, ultrasound during pregnancy was an exception. The reasons for the high frequency of multiple repeated ultrasounds during pregnancy are unknown, but large surveillance studies have demonstrated dramatic variations in the prevalence rates of fetal abnormalities, which are dependent in part upon institutional expertise.[28] The latest clinical guideline recommendations suggest that there is no evidence for second or third trimester ultrasound for low-risk pregnancies.[29]

Approximately half or more of all coronary angiograms result in a revascularization procedure.[6] The decrease in the number of repeat coronary angiograms over time may be attributable to an increase in the use of various co-interventions (e.g., increasing stents and anti-platelet therapies) associated with percutaneous coronary interventions (PCIs). These co-interventions decrease the appearance of PCI-related complications (e.g., re-stenosis, in-stent thrombosis) and thus might decrease the need for repeat angiograms over time. The temporal decrease in coronary perfusion imaging may relate to the evolution of acute coronary syndrome management, which has resulted in more aggressive use of early interventions thereby replacing the historical use of cardiac nuclear perfusion imaging for post-myocardial infarction risk stratification.

One might speculate that some of the single repeat sleep investigations may have been for sleep titration tests rather than for diagnostic evaluations, given that the prevalence of sleep titration repeat testing was disproportionately low when compared with prevalence of repeat tests among all sleep studies. Sleep titration tests evaluate the therapeutic response to sleep disorder interventions in those with sleep disorders and would replace the need for a repeat of a generic sleep study in this population. Also, billing codes for sleep titration tests are relatively new.

Chapter 6: Summary, Conclusions and Next Steps

There was an increase in the number of all diagnostic tests examined from 1996/97 to 2005/06; however, the magnitude of growth was variable (most marked for MRI and least marked for chest X-rays). The tests explored in this study were selected on the basis of their rising relative and absolute costs. Therefore, the extent to which such increases apply similarly to other diagnostic tests is unknown.

There was no clear evidence that growth in one test or technology occurred because it served as a replacement or substitution for other (perhaps older) technologies; however, only echocardiography and cardiac nuclear wall motion studies were examined in this regard. As well, there was no suggestion of inappropriate testing in this "test case" of two technologies with overlapping indications in the same patient population.

While demographic characteristics among patients receiving tests did not markedly change over the last year studied (2005/06), the frequency of investigations in the elderly (women in particular) increased over the decade for many tests. Absolute rates of testing among elderly men were higher than those among elderly women for most tests examined, particularly cardiac investigations. This finding is not new.

Socioeconomic disparities favouring affluent neighbourhoods were present for most tests, but were most marked for pelvic/intracavitary ultrasounds, pregnancy ultrasounds, and magnetic resonance imaging (MRI). The reason for such socioeconomic disparities is unclear, and may relate to variations in health-seeking behaviours, access to specialists, physician decision-making biases or clinical differences.

Regional variations existed for all tests, although for many, the magnitudes of variations were modest (under two-fold variations) and were similar in magnitude to regional variations observed for many surgeries in Ontario.[4] Sleep titration studies and cardiac nuclear perfusion tests were associated with the most marked variations, while chest x-rays and computed tomography (CT) scans had the smallest variations. None of the Local Health Integration Network (LHIN) regions were consistently low-rate or high-rate users of all tests, although three regions tended to have lower than average rates (South West, Wellington Waterloo, and with the exception of sleep studies, South East LHINs)" and two regions tended to have higher than average utilization rates (Central and Central East LHINs) for many tests. The regional correlation in tests providing similar diagnostic information on similar patient populations (e.g., MRI vs. CT) was poor. The proliferation of tests over time varied and did not increase uniformly across LHINs.

The average annual prevalence of repeat testing (one or more repeat tests within one year) was 20% of patients and 36% of tests, ranging from approximately 5% of patients and 10% of tests for transesophageal echocardiography to as high as 69% of patients and 89% of tests for ultrasound in pregnancy. Most investigations fell within the 10-30% range for patients and 20–40% range for tests. Many patients receiving at least one ultrasound in pregnancy received several repeats (three or more). The reason for such high rates of repeated pregnancy-related ultrasounds is unknown, but may be partially attributable to more aggressive fetal screening, patient demands, and evolving practice guidelines. The frequency of repeat testing rose for some tests (cardiac nuclear wall motion studies, ultrasound in pregnancy, MRI), and fell for others (sleep studies).

Determinants of regional repeat testing variations may be explained in part by patient factors (e.g., clinical indications, disease burden). However, for some tests, determinants are complex and are likely explained by a combination of system, physician and patient factors—some of which are difficult to quantify.

Due to the lack of information regarding test indication and results, the extent to which utilization patterns have been appropriate or inappropriate could not be easily ascertained and should not be inferred from the results of the study. The demographic shifts in utilization among older patients over time, which was observed across many tests, may be consistent with more aggressive referral behaviours among patients with high underlying disease burden and/or illness complexity. The absence of any consistent high- or low-rate regional outliers may suggest that difference across LHINs may be more dependent upon local factors (e.g., specialty physician supply, disease variations) than on pervasive or systematic physician referral practices. Nonetheless, due to the dramatic numbers of repeat tests and high rate of increase in repeated tests over time, pregnancy-related ultrasounds may be one area where the relationship between clinical practice and practice guidelines needs to be further examined.

While quantifying inappropriateness of testing may be difficult, further studies can help better determine the efficiency, yield or outcomes associated with inter-regional (and/or inter-physician) differences in testing intensity. These may be conceptualized into macro- and micro-studies. *Macro-studies* would involve a broader-based evaluation of the population as a whole and could utilize administrative data. Such studies could include exploration as to whether higher- or lower-rate regions (for a specific test in question) are associated with poorer or better outcomes, and might entail disease-specific cohorts to help adjust for variations in clinical severity. Conversely, *micro-studies* would require more detailed in-depth chart audits that could better capture test indication, test results and more refined clinical data—information which may not otherwise be available using administrative data. However, the extent to which such micro-studies draw useful clinical and policy inferences depends upon the types of tests examined, since patient, physician and system factors may be test-specific and exert varying influence on referral propensity. Pregnancy-related ultrasounds and sleep studies (initial and titration) may provide test case applications for such studies, and might entail chart audits and/or physician/patient surveys among high- and low- testing rate regions.

Part II
Jurisdictional Review of Diagnostic Services

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Introduction

Part I of this report highlighted the rising utilization and practice variation of diagnostic imaging services in Ontario. To better understand how to effectively manage these services within the Ontario health care system, a global review of how diagnostic imaging is managed in other jurisdictions was undertaken as a springboard to develop recommendations for sustainable and appropriate delivery of diagnostic services in Ontario. Data were obtained from peer-reviewed and grey literature, as well as from interviews with experts using structured questionnaires. The jurisdictions reviewed were: **British Columbia, Alberta, Manitoba, Quebec, the United States (Medicare, Veterans Affairs, Kaiser Permanente), the United Kingdom, Germany, France, Sweden, Japan and Australia.** The provision of diagnostic imaging services across jurisdictions was examined for the following components:

- Expenditures for health care and diagnostic imaging;
- Supply of imaging technology, imaging services and human resources;
- Policy for management and funding of diagnostic imaging services; and,
- Policy for introducing and monitoring new diagnostic technology (and for removing obsolete technology).

The findings were evaluated in order to elucidate overall policy options for Ontario in the areas of:

- Utilization and cost of diagnostic imaging;
- Appropriateness of diagnostic imaging;
- Intensity of diagnostic imaging and health outcomes;
- Transfer of knowledge into clinical practice;
- Health technology assessment;
- Obsolete imaging technology; and,
- Provision of diagnostic imaging by non-radiologists.

This report focuses on diagnostic imaging technologies because they comprise the majority of technologically advanced, high cost and rapidly growing diagnostic services in Ontario. Laboratory and pathology services, as well as genetic testing, were excluded from this report.

Chapter 1: Expenditures for Total Health Care and Diagnostic Imaging

Key Findings

- Seventy percent of health care in Canada is publicly financed, an amount which is slightly less than the average in other countries that report to the Organization for Economic Co-operation and Development (OECD).
- Ontario is similar to other Canadian jurisdictions in measures of total health expenditures.
- According to the Canadian Institute for Health Information (CIHI), Canada spent 10% of total outpatient expenditure on diagnostic imaging and 9% on laboratory services in 2003; national and international comparative data are not readily available because of differences in data collection and methods of expenditure calculation.
- Ontario government spending on the operating costs for non-laboratory diagnostic services represented approximately 5% of C$30.2 billion total operating costs of the Ministry of Health and Long-Term Care (MOHLTC) in 2003/04.

Total health care expenditures

Exhibit 1.1 compares the costs of total and public expenditures on health care by selected OECD member countries as well as expenditures on outpatient diagnostic imaging and laboratory services internationally. Canada was ranked ninth among 30 countries (spending 9.9% of its gross domestic product [GDP] on health care in 2003 compared to the OECD median expenditure of 8.6%), and was ranked 15th in total health expenditures per capita (US$2,664 per capita in 2003 compared with the OECD median of US$2,592 per capita).[30] In 2003, Ontario's total health expenditures were US$2,896 per capita, an amount which was above the Canadian average.[31] Data from CIHI indicate that Ontario's total health expenditures were close to the national average—10.1% of its GDP was spent on health care in 2003.[31]

In 2003, 70% of Canada's universal single-payer health care system was financed by the public sector. Ontario's public expenditure on health care was slightly lower than the national average in this year.[31] Public expenditure on health care in France, Japan and the United Kingdom (UK) was over 80%, while the United States (US) spent about 45%.[30]

Exhibit 1.1 Expenditures for health care and for diagnostic services across various jurisdictions*

Jurisdiction	Total expenditure on health (% GDP)	Total expenditure on health (US$ per capita)	Public expenditure on health (% of total)	Expenditure on outpatient diagnostic imaging (% of total outpatient expenditure)	Expenditure on outpatient laboratory services (% of total outpatient expenditure)
Australia	9.2	2,519	67.5	6.3**	5.4**
Canada	9.9	2,664	70.1	10.1	8.9
Ontario	10.1	2,896	67.1	N/A	N/A
British Columbia	11.2	2,793	N/A	N/A	N/A
Alberta	7.4	2,863	N/A	N/A	N/A
Quebec	10.2	2,464	N/A	N/A	N/A
France	10.4	3,096	78.3	0.7†	10.1
Germany	10.9	3,205	78.2	9.8	12.3
Japan	8.0	2,694	81.5	N/A	N/A
Sweden	9.3	3,155	85.4	N/A	N/A
United Kingdom	7.9	2,413	85.4	N/A	N/A
United States	15.2	5,711	44.6	N/A	N/A

GDP = Gross domestic product; N/A = Data not available.

* All data are from 2003 unless otherwise noted.

** 2002 data.

† 2001 data.

Expenditures on diagnostic imaging

Exhibit 1.1 presents information on outpatient diagnostic imaging and clinical laboratory testing as a percentage of total outpatient expenditures reported by the OECD. Unfortunately, this information is of limited comparative value because the proportion of these services delivered in outpatient and inpatient settings differs substantially between countries. For example, magnetic resonance imaging (MRI) and computed tomography (CT) are increasingly being provided in outpatient settings in the US,[8] whereas few of these services are provided outside of hospitals in the UK.[32]

Between 1994 and 2004, the Medicare Payment Advisory Commission (MedPAC) in the US reported that Medicare[†] spending on diagnostic imaging under the physician fee schedule increased 88% from US$5.8 billion to US$10.9 billion, outstripping growth in all other areas during that same time period.[2] Diagnostic imaging represented 3.5% of total Medicare expenditures (US$309 billion) in 2004.[33]

Rough estimates of expenditures on diagnostic services were obtained through interviews with Canadian experts. Ontario government spending on outpatient and inpatient *non-laboratory* diagnostic services for the 2004/05 fiscal year represented approximately 5% of the MOHLTC's total operating costs of $C30.2 billion, more than the Canadian Ministry of Natural Resources spent (C$1.3 billion)[34] and more than twice the amount the Ontario Ministry of Transportation spent (C$0.7 billion)[35] during the same fiscal year. In 2005/06, British Columbia (BC) reported a C$1.3 billion total expenditure for all diagnostic services, representing 14.8% of total spending (personal communication, Jean Yan, BC). These rough estimates are unofficial and preliminary, and should be interpreted with caution.

In Australia, Memoranda of Understanding (MoU) between the government and the various professional imaging associations allocated a total of AU$7.5 billion fee-for-service physician reimbursement for diagnostic imaging services over a five-year period (2003–2008).[36-39] Under these MoUs, AU$1.4 billion was earmarked for Medicare spending on diagnostic imaging services for the 2004/05 fiscal year, representing 14% of the AU$9.9 billion in Medicare benefits paid out during that year.[40]

[†] Medicare is a federal health insurance program that is available for people aged 65 years and older, younger people with disabilities and people with end-stage renal disease.

Chapter 2: Supply of Imaging Technology, Imaging Services and Human Resources

Regional variation in supply and utilization of computed tomography (CT) and magnetic resonance imaging (MRI)

Key Findings

- The number of computed tomography (CT) and magnetic resonance imaging (MRI) scanners per capita in Canada is below average compared to other developed countries. Ontario is below the Canadian average.
- Although utilization is roughly proportional to the number of machines available in a given jurisdiction, considerable variation in this relationship highlights that some units may be performing more efficiently than others.

Exhibit 2.1 provides measures of a jurisdiction's investment and efficient use of CT and MRI scanning. Canada ranked 18th in CT scanners per population among the 25 Organization for Economic Co-operation and Development (OECD) nations (10.4 CT machines per million population compared to a median of 14 CT machines per million population among OECD nations). Ontario had the fewest CT machines of any Canadian province or territory in 2003. Canada ranked 14th among the 26 OECD nations with available data on MRI scanners (4.6 MRI machines per million population in 2003, compared to a median of 5.4 MRI machines per million population among OECD nations). Ontario had fewer MRI machines than the Canadian average. Manitoba had fewer MRI machines than Ontario in 2003.[15]

In 2004/05, Canada performed nearly four times the number of CT exams per capita and two times the number of MRI exams per capita[15] than Sweden or the United Kingdom (UK) performed in 2002[30] (Exhibit 2.1). Ontario performed fewer CT exams than other provinces but more MRI exams than British Columbia (BC) and Quebec. Alberta performed substantially more MRI scans than other Canadian provinces. Utilization of CT scanning in the US elderly population was 45% higher than in Ontario.[3,4]

The number of CT and MRI exams per capita is roughly proportional to the number of scanners per capita across jurisdictions (Exhibits 2.2 and 2.3). However, there remains considerable variation in the relationship between the number of exams per capita and the number of scanners per capita as measured by patient throughput. Exhibits 2.2 and 2.3 suggest that countries with more machines are more likely to have times when the machines are idle (excess capacity), while countries with fewer scanners may be utilizing their equipment more efficiently. That is, at some points along the curve, the number of exams per capita appears to remain constant or even fall despite an increase in the number of machines.

Exhibit 2.1 Supply of diagnostic imaging equipment, imaging services and health professionals across various jurisdictions*

Jurisdiction	CT machines (per million population)	MRI machines (per million population)	CT exams** (per 1,000 population)	MRI exams** (per 1,000 population)	Radiologists† (per million population)	MRT¥ (per million population)	Radiologists: MRT
Australia	N/A	3.7	N/A	N/A	N/A	N/A	N/A
Canada	10.4	4.6	87.3	25.5	69	440	1:6
Ontario	8.0	4.1	79.4	27.4	66	392	1:6
British Columbia	10.7	4.4	78.2	18.4	61	382	1:6
Alberta	9.6	7.7	90.8	36.6	75	512	1:7
Quebec	13.0	5.1	90.1	21.7	79	483	1:6
France	8.4	2.8	N/A	N/A	110	330	1:3
Germany	14.7	6.2	N/A	N/A	105	300	1:3
Japan	92.6§	35.3§	N/A	N/A	N/A	N/A	N/A
Sweden	14.0¶	8.0¶	25.0	12.5	145	275	1:2
United Kingdom	6.7	4.4	22.0	10.0	30	295	1:10
United States	32.0∞	27.0∞	391~	114~	N/A	N/A	N/A

CT = Computed tomography; MRI = Magnetic resonance imaging; MRT = Medical radiation technologist (radiographer); N/A = Data not available.

* All data are from 2003 unless otherwise specified.

** Canadian data are from 2005.[15] European data are from 2002.[16]

† Canadian data are from 2004 and include nuclear medicine physicians and radiologists.[15] European data are from 2002 and do not specify the type of radiologist.[16]

¥ Canadian data are from 2004 and include nuclear medicine and radiological technologists.[15] European data are from 2002 and do not specify the type of radiographer.[16]

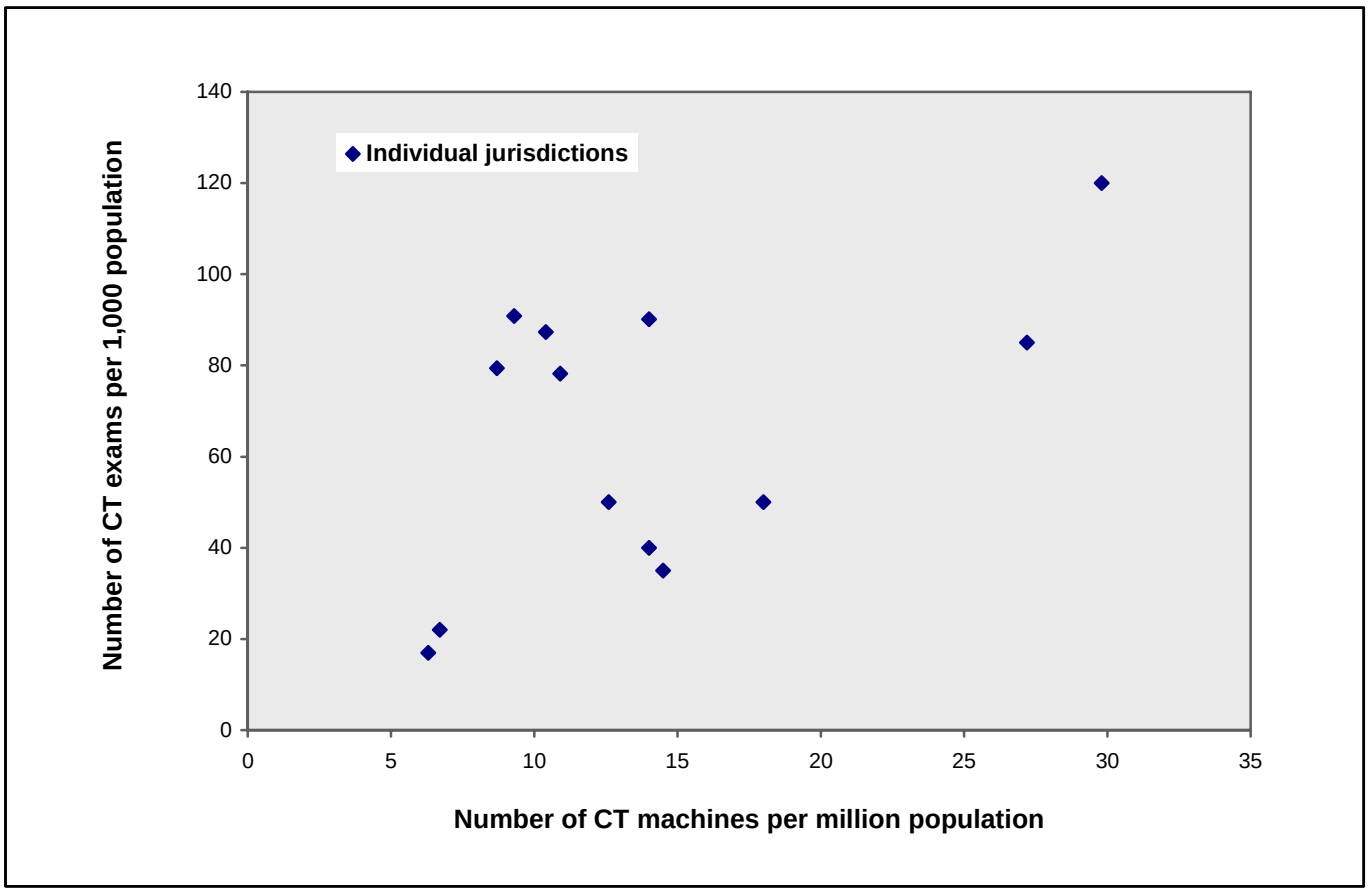
§ 2002 OECD data.[30]

¶ 2002 data.[16]

∞ 2004 data.[15]

~ 2001 Medicare data.[3]

Exhibit 2.2 Relationship between CT utilization (number of CT exams performed per 1,000 population*) and supply (number of CT machines per million population**) across various jurisdictions†

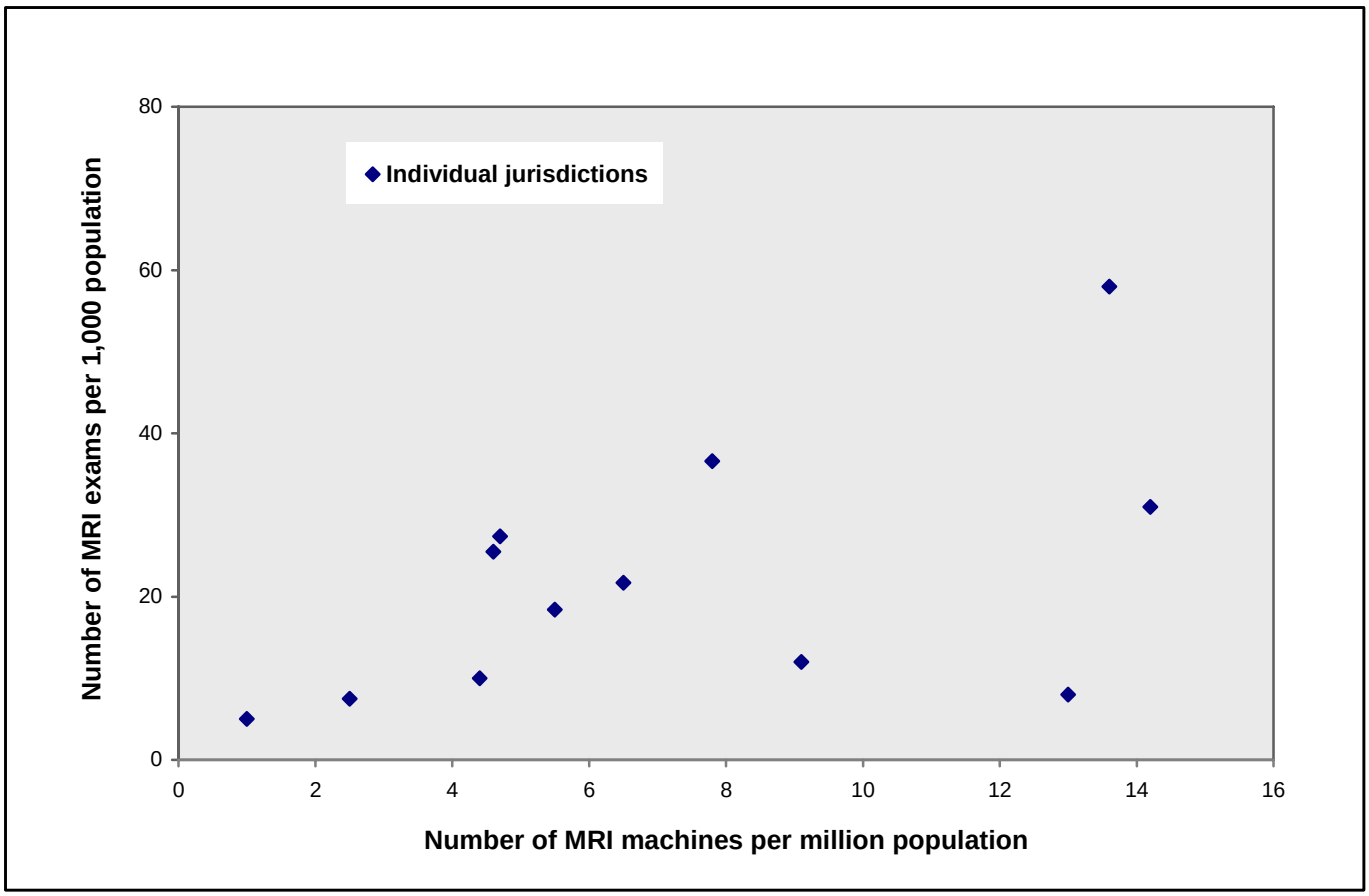


***** Data are from 2005 for all jurisdictions except for Europe which was studied in 2002.

****** Data are from 2003.

† Jurisdictions studied included: Alberta, Austria, Belgium, British Columbia, Canada, Czech Republic, Denmark, Finland, Ontario, Poland, Quebec, Switzerland, United Kingdom.

Exhibit 2.3 Relationship between MRI utilization (number of MRI exams performed per 1,000 population*) and supply (number of MRI machines per million population**) across various jurisdictions†



***** Data are from 2005 for all jurisdictions except for Europe which was studied in 2002.

****** Data are from 2003.

† Jurisdictions studied included: Alberta, Austria, British Columbia, Canada, Czech Republic, Denmark, Finland, Ontario, Poland, Quebec, Switzerland, United Kingdom.

Relationship between intensity of imaging use and health outcomes

Key Findings

- Little work has been done to study the relationship between the intensity of imaging use and health outcomes. One analysis of US Medicare data showed that greater spending for diagnostic imaging is not associated with improved survival.
- The appropriate level of diagnostic imaging use at the population level remains unknown.

Wide variation in the intensity of imaging use across jurisdictions exists; however, the "appropriate" level of utilization in relation to optimal health outcomes is not known. Researchers at Dartmouth Medical School in the US found that Medicare enrollees in higher-spending regions receive more care than those in lower-spending regions, but do not have better health outcomes. In fact, a trend towards higher mortality in higher-spending regions was found. One of the important factors responsible for greater utilization of health services in higher-spending regions was the more frequent use of diagnostic imaging tests.[41,42]

The Dartmouth group subsequently repeated these analyses for the Medicare Payment Advisory Commission (MedPAC), but with a specific focus on Medicare expenditures for diagnostic imaging rather than on total health expenditures. Once again, after controlling for differences in patient characteristics, their findings indicated that greater spending for diagnostic imaging was not associated with improved survival.[2]

Trends in utilization of diagnostic imaging services over time

Key Findings

- Population rates of diagnostic imaging (CT and MRI) in Ontario have increased markedly in the past decade.
- Despite higher baseline levels of utilization in the US, relative increases in rates of imaging have been very similar between Ontario and the US in recent years.

Between 1993/94 and 2003/04, the number of CT scans in Ontario increased by 300% and the number of MRI scans increased by 600%.[43] Between fiscal years 2001/02 and 2003/04, population rates of CT and MRI scanning increased by 15% and 30%, respectively—more rapidly than almost any other type of health service.[43]

Despite higher baseline levels of utilization, the US still experienced steady increases in the utilization of CT and MRI scanning, at rates of 10% per year for CT scanning (1998–2001) and 16.1% per year for MRI scanning (1998–2001).[3] These increases were of a similar magnitude to those seen in Ontario, with increases of 6.6–8.2% per year for CT scanning from 2001–2004, and 10.6–17.8% per year for MRI scanning.[4]

Similar trends have also been observed when comparing the utilization of cardiac imaging tests in the US and Ontario over time. In 1993, rates of imaging stress tests were 29.1 per 1,000 US Medicare enrollees. In 1992 in Ontario, rates of imaging stress tests were 9.9 per 1,000 population aged 65 years and older. The intensity of cardiac imaging utilization was nearly three times higher in the US in the early 1990s, yet there was still a 2.8-fold increase in the utilization of these tests among US Medicare enrollees by 2001. The same 2.8-fold increase was observed in Ontario over a similar time period.[6,44]

Regional variation in supply of radiologists and radiation technologists

Key Findings

- The supply of radiologists per capita in Canada is comparable to the average supply in other developed countries.
- There is a much greater variation across jurisdictions in the number of radiologists per capita than in the number of technologists per capita.

A summary of the radiological workforce in the different jurisdictions is found in Exhibit 2.1. In 2004, there were 69 radiologists per million population in Canada. Ontario had 66 radiologists per million population, and the supply of radiologists across the country was similar, ranging from 61 per million population in BC to 79 per million population in Quebec.[15] There was a five-fold difference between the country with the lowest (UK) and highest (Sweden) supply of radiologists among the jurisdictions studied for this report.[16]

Medical radiation technologists are trained on a wide variety of medical imaging devices and related equipment, but are not typically responsible for the official interpretation of the images they produce. There appeared to be wider variation in the number of radiologists compared to medical radiation technologists (referred to as radiographers in Europe) across these jurisdictions. In Canada, there were 440 medical radiation technologists per million population,[15] while in Sweden and France there were 275 and 330 radiographers per million population, respectively.[16] The UK had a one-to-ten ratio of radiologists to radiographers, whereas France, Germany and Sweden had one radiologist for every two to three radiographers.

Chapter 3: Policy for Funding and Management of Imaging Services

Funding frameworks for diagnostic imaging services

Key Findings

- Management of diagnostic services is not well developed in most jurisdictions.
- In Australia, diagnostic imaging management and medical practice policies are tied to Memoranda of Understanding (MoU), developed and signed by governments and professional associations to ensure the acceptance of all parties from the outset.
- In the United Kingdom (UK), diagnostic imaging services are funded through hospitals, while in the United States (US), Germany and some Canadian provinces services are funded within ambulatory settings.
- British Columbia and Manitoba have adopted a centralized approach to management and/or funding of diagnostic services—primarily for laboratory services rather than for imaging.
- In Ontario, capital funding for equipment tends to be government-directed while operating costs tend to come from hospitals directly.

The management of diagnostic service provision is not well developed in most of the jurisdictions reviewed. In most cases, patients are referred to diagnostic imaging services according to physician discretion and the tests are provided within the jurisdictions' health system regulations. Appendix C provides a brief summary of the health systems that were reviewed in this report.

Canada

In Canada, each Provincial Ministry of Health provides public health insurance for its residents through taxation revenue and essentially functions as the single payer for medically necessary hospital and physician services in that province, including capital and operational costs for diagnostic imaging. The provinces studied in this report have all adopted a regional model of health care delivery in which regional health authorities are responsible for the planning and delivery of health services within their regions and are given global budgets each year by the provincial government for this purpose. This process is still in its infancy in Ontario. Although the majority (70%) of health care funding comes from the public sector in Canada, the private sector remains an important source of financing for many supplementary health care services, such as pharmaceuticals, dental care, vision care and services from other health care practitioners.

Exhibit 3.1 Funding arrangement for diagnostic services in selected Canadian provinces

Province	Inpatient professional reimbursement	Outpatient reimbursement	Private reimbursement	Location of CT and MRI service provision	CT and MRI reimbursement
British Columbia	Hospital budget	FFS	Yes, for designated clinics	Hospital and clinic	Hospital budget if in hospital; private if outside
Alberta	FFS	FFS	Yes, for designated clinics	Hospital and clinic	Hospital budget if provided in hospital; private if outside
Manitoba	FFS	FFS and salary, contract or sessional fee	No	Hospital only	Hospital budget
Ontario	Hospital budget	FFS	No	Hospital only	Hospital budget
Quebec	N/A	N/A	Yes, for designated clinics	N/A	Public if provided in hospital

CT = Computed tomography; FFS = Fee-for-service; MRI = Magnetic resonance imaging; N/A = Not available.

Exhibit 3.1 illustrates the variation in the way that physician and technical fees are reimbursed for diagnostic imaging in Canada. Information for this exhibit was gathered through interviews with experts. In 2002, a non-profit corporation called Diagnostic Services of Manitoba was established "to deliver a centrally managed diagnostic system for Manitoba that is sustainable, state-of-the-art, cost-effective and known for its high quality and exceptional customer service". Its initial focus has been to centralize Manitoba's public laboratory and rural diagnostic imaging services.

In Quebec, all professional fees, whether for inpatient or outpatient services, are paid on a fee-for-service (FFS) basis. Technical fees for inpatients are funded through hospital global budgets whereas technical fees for outpatients are billed as FFS. Similar to Alberta, computed tomography (CT) and magnetic resonance imaging (MRI) services in Quebec are only publicly insured if they are performed in a hospital.

United States

Diagnostic imaging in the United States is provided within Health Maintenance Organizations (HMOs) and privately. Private hospitals and individual physicians may purchase imaging equipment and offer services to patients who pay out-of-pocket or through private health insurance plans. Persons insured under Medicare and Medicaid receive publicly funded diagnostic services according to pre-designated schedules. Kaiser Permanente is a large, primarily privately-financed, US HMO that has 8.5 million enrollees, 6.3 million of whom live in California. Decisions about acquiring diagnostic imaging equipment are made at the regional level, based on cost/benefit data provided by the HMO's Interregional New Technologies Committee (INTC), and on the availability of a "critical mass" that would justify the adoption of the new technology. Capital projects are funded through Kaiser Permanente's operating revenue.

Europe

Germany

Hospitals in Germany are reimbursed from the "sickness funds" (health insurance funds) for the operating costs of providing diagnostic imaging services through case-based payment (Diagnosis Related Groups methodology), whereas responsibility for the financing of capital investment rests with the state governments.[32] German hospitals provide few outpatient services. Instead, there are a large number of independent clinics, often equipped with sophisticated diagnostic equipment.[45]

France

In the past, most large diagnostic equipment such as MRI would have been subject to central planning by the Ministry of Health and would have required prior authorization. Recently, there have been efforts to streamline and decentralize the planning process for capital expenditures. As a result, increasing responsibility is being given to regional hospital agencies. Physicians are paid for outpatient diagnostic imaging services on an FFS basis, either directly by patients or by the "sickness fund".[45,46]

United Kingdom

Regional Primary Care Trusts (PCTs) that are funded by the Department of Health based on population medical need, administer primary care and public health delivery in their region and purchase a wide range of services, including diagnostic imaging services, from National Health Service (NHS) Trusts (who manage NHS hospitals). The NHS Trusts pay for capital investment themselves through a variety of funding means. Private donations and charitable grants are important sources of funding for capital equipment. In fact, almost 10% of medical equipment in the NHS is funded by charitable organizations.[47-49]

Since publicly funded diagnostic imaging services are only available in UK hospitals, physicians that provide diagnostic imaging services are paid through salary.

Sweden

Sweden has a system of publicly funded universal health care in which overall health policy is set by the state and health care delivery is organized at the regional level. Hospitals traditionally receive a relatively high proportion of total medical resources, including funding for diagnostic services.[50] There does not appear to be particular management of diagnostic services in Sweden.

Australia

Australia has an advanced management system for provision of diagnostic imaging services. The schedule of benefits is managed by the Australian Government Department of Health and Ageing, and outlines the fees payable by Medicare for outpatient diagnostic imaging services. The provision of publicly funded diagnostic imaging is managed through agreements called Quality and Outlays Memoranda of Understanding (MoU), which were instituted in July 2003 for a five-year period. The four MoUs (Radiology, Nuclear Medicine, Cardiac Imaging, and Obstetric and Gynecological Ultrasound) were negotiated between the government and the relevant professional associations. The MoUs outline the terms, conditions and overall amounts of funding for diagnostic imaging services and have a particular focus on monitoring utilization and improving quality of care.[36-39] Positron emission tomography (PET) scanning is not covered under the Nuclear Medicine MoU, but is managed solely by the government and is currently only being funded for specific clinical indications, such as epilepsy, solitary pulmonary nodules and staging for non-small cell lung cancer.

Japan

Japan's system of mandatory universal health insurance requires that citizens receive from either of two streams: Employees' Health Insurance, which covers salaried workers and sets premiums proportional to income (half paid by the employee and half by the employer); or, National Health Insurance, which covers workers in agriculture, forestry and fisheries, as well as self-employed and non-employed individuals. The FFS payment for physicians and for each prescription or test that is ordered may encourage quantity rather than quality of care. In fact, Japan has the third highest number of physician consultations among Organization for Economic Co-operation and Development (OECD) countries and the greatest number of MRI and CT scanners per capita of any OECD country. Indeed, consultations in Japan have been previously termed "three-hour wait, three-minute contact", describing a physician-patient encounter in which the emphasis of the consultation is on ordering tests and prescribing drugs.[51-53] Further, there is no evidence of a managed diagnostic service provision system.

Human resource issues

Key Findings

- Many jurisdictions appear to have shortages of radiologists and technologists, although the optimal number of radiologists and technologists per capita is unknown.
- Innovations, such as picture archiving and communication systems (PACS) and teleradiology, are offering some solutions to radiologist shortages.
- The ability to update skill-mix among technologists is a significant challenge, given the rapid pace of innovation in imaging technology.
- Increasing provision of imaging services by non-radiologists (e.g., cardiologists) poses several challenges, including updating of standards for accreditation, "turf wars" within the medical profession and concerns regarding self-referral.

Canada

Surveys conducted for the Canadian Association of Radiologists (CAR) have indicated that the number of unfilled positions in Canada rose from 59 in 1995 to 105 in 1998, while the number of new radiologists being produced declined from 87 in 1994 to 69 in 1998. The CAR has warned that the situation will not improve unless the number of radiology graduates increases from about 70 to between 135 and 150 annually.[54] Teleradiology is increasingly being used in several jurisdictions to address this problem. For example, Manitoba is implementing a province-wide PACS, so that expert interpretation of images can be performed remotely.

The Canadian jurisdictions studied in this report universally expressed a significant shortage of technologists (medical radiation technologists and ultrasound technologists). Medical radiation technologists produce diagnostic images and perform diagnostic and therapeutic interventions,[55] but in actual practice do not officially interpret images or perform therapeutic interventions. The aging of the workforce, insufficient capacity of training programs and retention of trained staff were factors contributing to the shortage of technologists across all provinces. A further challenge was retraining staff with advancing imaging technology (personal communication, Blake McClarty, Manitoba).

An increasing number of non-radiologists, particularly cardiologists, are performing imaging tests and interpreting results. According to some professional bodies, this phenomenon poses challenges to accreditation and quality assurance.

United States

The radiologist shortage reported in the late 1990 has eased in recent years.[56,57] Instead, the most prominent human resource issue in the US appears to be the increasing number of subspecialties performing diagnostic imaging and the increasing costs generated by self-referral practices resulting from these changes. This can occur when non-radiologists purchase diagnostic equipment and operate their own imaging centres. This creates a situation where physicians can refer their patients to imaging centres in which they have a financial interest. The Government Accountability Office has reported that when self-referral takes place, imaging volumes increase by up to 54%.[58] Another study found that for 10 common clinical presentations, self-referral resulted in 1.7 to 7.7 times more frequent performance of imaging examinations than radiologist-referral.[14,59]

Radiologists in the US have been using such data to support a vocal campaign attributing the growth in diagnostic imaging use to non-radiologists (particularly cardiologists) who are performing imaging tests in their own offices.[14] Cardiology imaging groups have countered back, arguing that advances in technology are bringing imaging devices to the bedside and that their use is both necessary and appropriate. To address these issues, legislation has been passed (*Ethics in Patient Referrals* Act—commonly referred to as the Stark Laws I and II) in the US to prohibit the referral of a patient to a facility in which the physician also has a financial interest. However, the Stark laws have been largely ineffective in preventing self-referral because there are many loopholes and the laws are inconsistently enforced.[60]

Europe

The European Association of Radiologists published a report in 2002 on benchmarking of radiological services. They found that non-radiologist reporting of diagnostic imaging examinations was still relatively uncommon. Radiologists reported all imaging examinations in six countries, and only a few jurisdictions had non-radiologist reporting of results. However, this is likely to change as CT replaces coronary angiography, and dedicated MRI systems become more widely marketed.[16]

The UK reports a shortage of radiologists, with a vacancy factor of 3.6%. In comparison to other European countries, the UK has among the lowest number of radiologists per capita and the government has increased spending in order to address this shortage. As a result, the UK relies heavily on radiographers. In addition to the production of diagnostic images, these radiographers often carry out additional responsibilities such as pre-reading films and administering contrast agents, thereby reducing the workload of over-extended radiologists. Since radiologists in the NHS are paid by salary, the system is conducive to the use of non-radiologists to perform these additional duties and even interpret films. A shortage of radiographers is also reported in the UK.

There is a wide disparity in the number of radiologists per capita across different European countries, and a lesser discrepancy in the number of radiographers per capita (Exhibit 2.1). In addition, there are a significant number of countries that are not replacing their present workforce of radiologists or radiographers. These projected shortages do not take into account the need for continuing professional development, the anticipated increase in future workload and the ongoing rise in population.[16] In France, modeling projections based on current trends in career choice and the number of available training positions have predicted that there will be a 32% drop in the number of radiologists by 2020.[61]

Australia

Australia is experiencing similar radiologist shortages to Canada. Based on an empirically-determined target distribution of three radiologists per 100,000 population, the Australian Medical Workforce Advisory Committee concluded that there was a need for 37 full-time specialist radiologists, with an anticipated increase in the shortfall of 1.5% per year. The committee recommended that graduate output be increased from 36 to 52 radiologists per year in 2009–2011, and that 60 additional training positions be created across three years commencing in 2002. Distribution of radiologists between public and private sectors was also identified as an important problem. Some of the barriers to retention of radiologists in the public sector were the lack of competitive public sector remuneration and poor working conditions in public facilities. Supply of radiologists in rural areas was felt to be adequate, and similar to other jurisdictions studied in this report, teleradiology using PACS solutions has facilitated the provision of imaging services in geographically remote areas.[62,63]

Non-radiologists are allowed to self-refer patients for imaging tests. However, in contrast to the US, there is no evidence to indicate that this practice was leading to substantially increased utilization of imaging tests. Legislation currently prohibits physicians from inducing referrals through the provision of financial incentives (or disincentives) to potential referring physicians. This legislation was initially developed for pathology services and has more recently been extended to include imaging services.[64,65]

Appropriateness of diagnostic imaging: utilization management

Key Findings

- Most peer-reviewed literature regarding appropriateness of diagnostic imaging comes from the US.
- Many jurisdictions have clinical practice guidelines regarding appropriate referral practices for imaging services; however, uptake is unknown.
- Clinical decision support software is being used in some US jurisdictions to enable real-time integration of guidelines into practice. Similar initiatives are being piloted in some Canadian provinces.
- In Australia, payment is linked to appropriateness guidelines for a limited number of clinical scenarios.

In general, an intervention is deemed clinically appropriate when the benefits outweigh the risks. Performing interventions in situations of no, or very little, net benefit may waste health service resources, may not improve health at the population level and may even be harmful for patients. Some diagnostic imaging modalities carry risk of radiation exposure and false positive test results may carry the risks of false disease diagnosis, patient anxiety and further tests or invasive procedures (e.g., biopsy). These risks will exceed any potential benefits if the scans are performed in patients with a very low likelihood of disease. At a societal level, appropriateness takes on the added dimension of cost-effectiveness. For an intervention to be appropriate, the overall use of the intervention should be affordable.

Evidence-based clinical practice guidelines can help clinicians to determine the appropriate indication for a test. However, there are several challenges to the development of clinical practice guidelines for diagnostic imaging:

- The evidence to support the use of an imaging test in specific clinical situations may be conflicting, incomplete, or of poor quality;
- It is difficult to capture the nearly infinite number of appropriate reasons for ordering an imaging test;
- The pre-test likelihood of disease is often incorporated into practice guidelines; and,
- Clinical practice guidelines will not, in and of themselves, translate into improved quality of care.[66] Knowledge translation strategies need to be implemented for most guidelines to have a significant impact on physician behaviour.

Most of the peer-reviewed literature on the inappropriateness of diagnostic imaging use comes from the US, Canada, Taiwan and Germany.[5,7,67] In contrast, one article describing MRI utilization suggests that these concerns do not exist in the UK, stating that there was “little evidence of inappropriate MRI use in West Midlands region of the UK, but considerable evidence of under-provision”.[68]

Canada

The Canadian Association of Radiologists (CAR) recently published its first edition of clinical practice guidelines for diagnostic imaging. The document stresses physician autonomy, stating that the guidelines are not intended as a means of restricting the physician's role in the process of decision-making for imaging study requests.[69] There is no regulatory mechanism in Canada for the enforcement of these guidelines.

BC's Diagnostic Accreditation Program (DAP), which is legally responsible for accrediting all imaging facilities in the province, has recently endorsed the CAR diagnostic imaging referral guidelines. Implementation is not mandatory, but it is directly recommended for accreditation. The DAP, however, does not directly enforce the CAR guidelines.

The BC Ministry of Health is particularly concerned about the appropriateness of laboratory testing. These concerns were flagged by data that BC spent a disproportionate amount of its health budget on laboratory testing compared to national trends. This prompted the establishment of the Provincial Laboratory Coordinating Office (PLCO) whose major roles are to develop a comprehensive plan for an improved delivery model and better utilization management, and a long-term strategic investment plan that will provide opportunities to help modernize and improve the delivery of lab services in BC. While some concerns also exist in BC regarding the appropriateness of diagnostic imaging, when local experts were contacted they did not convey a sense that the provincial government was prepared to engage in a similar initiative for imaging technology. However, there was some interest at the health authority level in piloting clinical decision-support software that would integrate clinical practice guidelines into a computerized physician order entry system.

Alberta health regions expressed interest in adopting clinical decision-support software however, they are not yet at the stage of pilot testing or implementation. One isolated example of utilization review and management is the Alberta Breast Cancer Screening Program which performs audits on screening mammography use and only pays for one screening mammogram per year.

In Manitoba, one of the prime targets for achieving improvements in the effective utilization of diagnostic imaging was the integration of clinical practice guidelines into an electronic physician order entry system. Such clinical decision-support software is currently undergoing evaluation (personal communication, Blake McClarty, Manitoba).

United States

The American College of Radiology published a detailed set of appropriateness criteria for the use of diagnostic imaging and has taken an international leadership role in advancing patient safety and quality of care. Since the 1990s, private insurers took a much more active role in monitoring providers and the services rendered, and insurers and employers increasingly relied on the more stringent controls of these plans as a means of containing cost. Many plans now emphasize the importance of quality of care and patient safety, and reward performance based on evidence-based quality indicators and systems. For example, the Veterans Affairs and Kaiser Permanente have implemented sophisticated guideline-based, clinical decision-support technology, which is also facilitated by the existence of a remarkable level of information technology infrastructure. In the Kaiser Permanente system, for example, the Care Management Institute was developed to collect evidence which could be embedded into processes of care.

The Partners HMO, encompassing a number of Harvard teaching hospitals including the Brigham & Women's Hospital, has established the Centre for Evidence Based Imaging (CEBI), which has taken a pioneering role in integrating clinical practice guidelines into physician workflow. Under this system, physicians request imaging tests using a web-based computer order entry system that notifies them if a similar scan has recently been performed, provides a view of the images and the radiologist's official report. This has been shown to decrease the frequency of unnecessary repeat testing (personal communication, Ramin Khorasani, US). The system also asks for the test indications and alerts physicians if these reasons are not consistent with clinical practice guidelines. The system can refuse or accept the requisition for the test, can initiate telephone consultation with a staff radiologist to further discuss the request, or simply document the deviation from clinical practice guidelines and proceed with on-line scheduling of the imaging test.

Europe

The Royal College of Radiologists in the UK has published guidelines entitled, *Making the Best Use of a Department of Clinical Radiology*.[70] The guidelines rate imaging tests across a variety of scenarios as "indicated", "specialized investigation", "not indicated initially", "not indicated routinely" and "not indicated". Although adherence to these guidelines is voluntary and not strictly enforced, they have gained considerable uptake within the UK and are now in their 5th edition (personal communication, Alan Moody, Ontario).

In France, clinical practice guidelines have been recently developed by the Société Française de Radiologie (SFR) and the Société Française de Biophysique et de Médecine Nucléaire (SFBMN) entitled, *Le Guide du bon usage des examens d'imagerie médicale*. The level of enforcement for these guidelines is not known.

Australia

In Australia, diagnostic testing management in specific clinical settings has been through the Medicare fee schedule, rather than through clinical practice guidelines or clinical decision-support software. Depending on the specific clinical indication, Medicare will pay for MRI scans only a certain number of times per year and only at the request of a recognized specialist or consultant physician.[71] A national set of diagnostic imaging guidelines have been developed to encourage the cost-effective and appropriate use of diagnostic imaging services. However, as is commonly the case, they only serve as a guide for referring physicians and are not enforced.

Chapter 4: Policy for Diagnostic Imaging Technology

Role of health technology assessment in funding new imaging technology

Key Findings

- Health technology assessment (HTA) evaluates the clinical effectiveness of new technologies and may be used to inform diagnostic imaging management decisions; HTA is used in varying degrees across jurisdictions.
- Studies of efficacy and clinical effectiveness for diagnostic imaging are elusive. Therefore, it is difficult for HTA agencies to make explicit recommendations on diagnostic imaging use based on evidence.
- The Canadian Agency for Drugs and Technologies in Health (CADTH) serves as a national agency to evaluate and make recommendations on new medical devices.
- The Ontario Health Technology Assessment Committee (OHTAC) has a unique partnership with the Ontario Ministry of Health and Long-Term Care to examine evidence for integrating new health technologies into the Ontario health system.
- There is growing interest in using field evaluations as part of the HTA process.

Regulatory guidelines for medical device manufacturers focus on safety, rather than on clinical effectiveness. Therefore, there are few randomized clinical trials evaluating the benefits and harms of diagnostic imaging when they are licensed for sale. Decisions to fund or adopt imaging devices are made by those paying for the technologies. HTA attempts to bridge science and policy through rigorous systematic review of the literature, an analysis of costs and benefits of the technology, and sometimes a budget impact analysis as well as consideration of broader ethical and societal issues.[70] The role of formal HTA to inform policy on diagnostic imaging technology varied across the jurisdictions studied.

Canada

The national CADTH (formerly Canadian Coordinating Office for Health Technology Assessment [CCOHTA]) receives funding from provincial Ministries of Health, as well as from the federal Ministry of Health, and has performed several HTAs on diagnostic technology. CADTH is accountable to federal and provincial deputy ministers of health via its Board, and priorities for HTA are recommended by an advisory committee with representation from the federal and provincial health ministries.

HTA is also performed at the provincial level. The British Columbia Office of Health Technology Assessment (BCOHTA) was established in the early 1990s but disbanded in 2002 due to loss of funding. Therefore, some organizations such as individual hospitals and regional health authorities perform their own informal HTAs. Decisions regarding the adoption of expensive imaging equipment typically originate more from health authorities who tend to gain information from academics and leading researchers within a given field and less from formal HTA evidence (personal communication, Sharmen Vigouret-Lee, BC). In addition, the BC Advisory Committee on Diagnostic Facilities (ACDF) provides advice to the Minister on issues including diagnostic imaging technologies. The Diagnostic Accreditation Program (DAP) may receive queries about the effectiveness and utility of new technologies from the ACDF who rely on the DAP for expert opinion. The advice they provide is informal and does not follow an explicit, transparent or heavily evidence-based HTA process (personal communication, Sharmen Vigouret-Lee, BC).

The Alberta Heritage Foundation for Medical Research (AHFMR) informs the Alberta Ministry of Health and the health regions about the effectiveness of new medical technologies. Despite the release of a document called The Burden of Proof: An Alberta Model for Assessing Publicly-Funded Health Services,[72] personal communications with contacts from Alberta suggest that AHFMR does not have the capacity to respond to all requests and is not always consulted in the policy decision-making process. The health regions, therefore, have developed their own informal HTA processes for adopting new imaging technology.

Decisions in Manitoba about new imaging technology are made at the provincial level by the Ministry of Health. There is currently no provincial HTA agency. The recently formed non-profit corporation, Diagnostic Services of Manitoba, has technical and medical directors within its governance structure who will have a role in advising the corporation regarding the purchase of new equipment. However, it is not yet clear what role formal HTA will play in this new organization.

L'Agence d'évaluation des technologies et des modes d'intervention en santé (AETMIS) is a provincial HTA agency in Quebec that is funded by the Ministry of Health. The HTAs gain traction in the health system by monitoring the Health Minister's responses to recommendations made by AETMIS. There is recognition that the analytic methods may need to be different for imaging technologies because of challenges in identifying the "correct" outcome measure to study when evaluating diagnostic testing.

Created in 2003, the Ontario Health Technology Advisory Committee (OHTAC) is an independent expert body established as a portal for providing advice to the Ontario health care system for the uptake, diffusion and distribution of new health technologies and the removal of obsolete ones. The Medical Advisory Secretariat (MAS) is the scientific body that develops Health Technology and Policy Assessments (HTPAs) within the MOHLTC, and informs OHTAC of findings after HTA and peer review. OHTAC makes recommendations to the Deputy Minister of Health who is legislated to respond back with implementation strategies within 60 days of receiving the OHTAC recommendation. MAS/OHTAC may recommend field evaluations of promising health technologies when there is insufficient evidence of effectiveness. For example, field evaluations of 64-slice CT coronary angiography and positron emission tomography scanning are currently under way. These were initiated because there was insufficient evidence to support the widespread provincial funding of these technologies, despite pressures for diffusion throughout the province.[73,74]

United States

In the US, there is unprecedented demand from the public for rapid access to the most sophisticated diagnostic technology; however, large private employers who purchase health care for their employees are becoming increasingly concerned about the value they are receiving for their rising expenditures. These concerns are improving the climate for more public-private cooperation in HTA research.[75] The Center for Medicare and Medicaid Services (CMS), the federal agency responsible for administering Medicare and Medicaid, has a significant influence on health policy development in the private sector through HTAs and guidelines developed by the Agency for Healthcare Research and Quality (AHRQ). In 2002, more than half of the HTAs completed were for diagnostic technologies.[75]

In addition to CMS, the Veterans' Health Administration (VHA), the Department of Defense (DOD) and insurers such as Blue Cross Blue Shield conduct HTAs as a decision-making tool. The VA Technology Assessment Program (VATAP) produced a report summarizing the approach of the Management Decision and Research Center Technology Assessment Program to evaluate diagnostic technologies.[76] In it, the authors recognize the importance of examining evidence for diagnostic testing accuracy as well as a causal link between test use and improved patient outcomes.

Europe

The UK has a well integrated system for evidence-based decision-making to inform health policy. The National Institute for Health and Clinical Excellence (NICE) produces technology appraisals and clinical guidelines. All National Health Service (NHS) organizations are theoretically required to implement NICE recommendations set forth in their technology appraisals. However, NICE does not have the power to enforce its recommendations and 10% of them have either been delayed or have failed in their implementation.

In France, the Haute Autorité de Santé (HAS) subsumed several HTA agencies in 2005 to assess the clinical utility of all health care procedures, services and products reimbursed by the National Health Insurance system.[77] Prior to this agency, a World Health Organization (WHO) report described the assessment of new technologies in France as only partial, with much of the initiative for assessment left to providers.[78]

The Swedish Council of Technology Assessment in Health Care (SBU), established in 1987, promotes the efficient use of resources allocated to health services and evaluates new and established technologies. Conclusions and findings are disseminated centrally and locally. HTA activities include the assessment of diagnostic imaging technologies and production of reports—reports on CT colonography (virtual colonoscopy) and the use of CT scanning for lung cancer screening have been produced.[79] The recommendations examine impact on patient health outcomes, but do not provide explicit criteria for supporting a given test.

Australia

The Medical Services Advisory Committee (MSAC) was set up in 1998 to assess evidence in order for a technology to be eligible for public payment in the Australian Medicare Benefits Schedule (MBS). A recent evaluation has raised some criticisms of the MSAC process:

- Decisions not to fund new technologies are being made because there is insufficient evidence to support their use, rather than because there is high quality evidence demonstrating lack of benefit;
- Application for MSAC evaluation is voluntary, and therefore the program has relatively low uptake;
- Technologies often diffuse into clinical practice prior to thorough evaluation; and,
- There are significant time delays between application for evaluation, performance of the HTA, and the final evaluation—a common criticism of formal HTA in all jurisdictions.

One solution that has been proposed to balance the need for greater evidence and the desire to avoid withholding potentially beneficial technologies from society is to provide interim funding for technologies, on the condition that further systematic collection of evidence regarding its effectiveness will be collected.[80] Support for such "field study" approaches to HTA is gaining momentum in Ontario and Quebec.

Removal of obsolete imaging technologies

Key Findings

- There is little emphasis placed in the HTA process on the removal of obsolete imaging technologies.

In general, HTA activities across jurisdictions are focused on assessing the cost-effectiveness of expensive new technologies. There is, however, a growing sense among the HTA community that more attention needs to be focused on evaluating the removal of older technologies since "things are always added, but things are never removed" (personal communication, Robert Lee, Alberta). OHTAC in Ontario explicitly identifies "the removal of obsolete health technologies" as being within its mandate.

Limitations and Next Steps

This report was considered to be an environmental scan to highlight broad issues that are impacting the management of diagnostic testing around the world. More detailed research papers stemming from issues raised in this report may be required. Some information relevant to this report could only be gleaned from interviews with local experts and therefore is subject to the personal opinions, interests and biases of the individuals providing the information. Genetic testing was excluded from this report, but it has the potential to become an increasingly important issue over the next decade. Dedicated research into policy regarding genetic testing and genetic screening in other jurisdictions may be warranted.

Chapter 5: Summary of Policy Options for Ontario

1. Policy recommendation: Utilization and cost of diagnostic imaging

Consult with other national and international organizations to develop a standard and comprehensive method for recording and reporting diagnostic imaging utilization and cost. Attention to the cost of diagnostic imaging testing itself and to downstream savings and costs (e.g., from further investigations for "incidentalomas" or false positives) is required.

Policy appraisal:

- Ontario government spending in 2004/05 on non-laboratory diagnostic services operating costs (primarily diagnostic imaging) represented approximately 5% of Ontario's health care budget.
- The actual costs are higher if one also considers the capital costs of equipment and the costs of downstream tests and interventions due to imaging results.
- The Ontario health care budget is large (C$30.2 billion in fiscal 2004/05) compared to other government Ministry spending.
- Costs of diagnostic imaging are increasing rapidly, and are likely to increase even more quickly in the near future given the current government's investment to increase computed tomography (CT) and magnetic resonance imaging (MRI) capacity.
- There is no standardized method for collecting comprehensive utilization, cost and appropriateness information about diagnostic imaging. It is therefore difficult to make accurate comparisons across jurisdictions.

2. Policy recommendation: Appropriateness of diagnostic imaging

Adopt a universal, province-wide, web-based system for ordering diagnostic imaging tests that would allow clinicians to access the results of previous imaging tests and thus decrease the frequency of unnecessary repeat testing. This could be built upon findings from pilot testing in Ontario and other provinces, such as Manitoba and Nova Scotia. Real-time identification of areas where test ordering appears to be incongruous with evidence-based practices could be evaluated. Until such a system is adopted, targeted chart reviews would prove useful for identifying areas where appropriateness may be a concern.

Policy appraisal:

- While all jurisdictions seem to be concerned about the increase in resources being spent on diagnostic imaging, none have found an effective method with which to determine appropriateness.
- Jurisdictions with much higher rates of diagnostic imaging than Ontario, such as the United States (US), continue to experience comparable increases in the rates of imaging, including CT, MRI and cardiac stress tests.
- Simply increasing the number of scanners in Ontario, without instituting methods to encourage the appropriate use of imaging technology, will lead to persistent increases in expenditures on diagnostic imaging.
- Routinely collected information about diagnostic imaging in Ontario lacks the level of clinical detail that is needed to examine appropriate use. Introducing universal, web-based methods of ordering diagnostic imaging—including reason for the test—could allow clinicians, managers and researchers to examine areas where test ordering is discretionary.
- Such a system could also provide evidence-based decision-support for clinicians at the time a test is ordered and could expand efficiency of the system by providing provincial patient-specific testing information.
- Selected chart reviews, such as those currently being conducted by the Institute for Clinical Evaluative Sciences for CT and MRI scanning, may prove useful for identifying areas where appropriateness may be a concern.

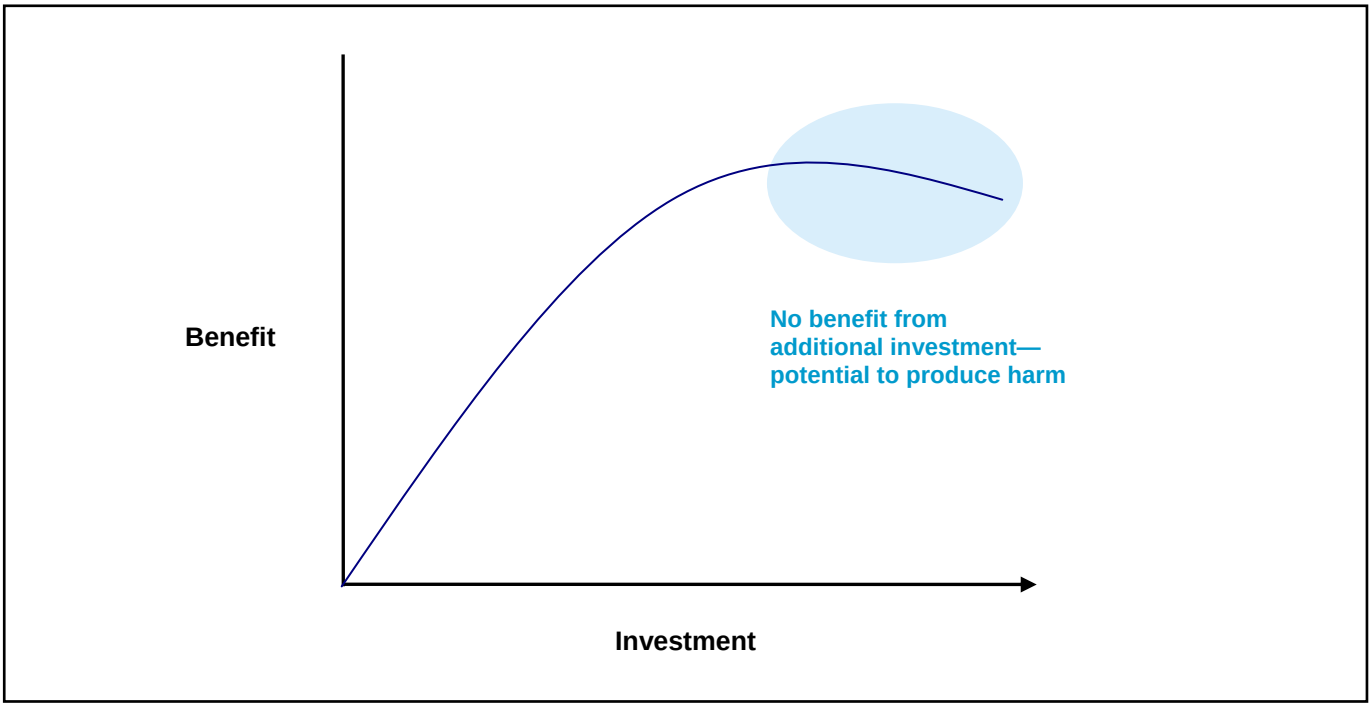
3. Policy recommendation: Intensity of diagnostic imaging and health outcomes

A population-based study that seeks to understand the relationship between the intensity of diagnostic imaging use and health outcomes in Ontario is necessary to fully understand reports from the US Medicare population which suggest that higher spending for diagnostic imaging does not lead to improved health outcomes.

Policy appraisal:

- An assumption that more health care will lead to improved health outcomes is prevalent. However, the *law of diminishing returns* suggests that at some point additional investment will yield no benefit and that there may be a point at which additional growth or investment might actually produce harm because of iatrogenic disease* (see Figure 1).

Figure 1: The law of diminishing returns—the relationship between investment and benefit



- The relationship between intensity of imaging use and population health outcomes is unclear. One study conducted in the US Medicare population found that survival was not improved in regions with higher rates of diagnostic imaging. This result may or may not be generalizable to Ontario.
- While imaging tests are generally perceived as low-risk, more imaging may theoretically lead to harm:
  - False positive results carry many risks including: false labeling with disease, patient anxiety and unnecessary downstream tests or invasive procedures (e.g., biopsy);
  - More imaging creates the potential for detection of "pseudo disease"—disease that would never become apparent to patients during their lifetime without testing. Since new diagnoses rarely go untreated, more imaging may lead to treatment being prescribed in situations where the risks outweigh the benefits; and,
  - Physicians may be more likely to make mistakes and to be distracted from the issues of greatest concern to their patients because there are more diagnoses to treat and more treatments to provide.

* Any adverse effect associated with a medical practitioner or treatment.

4. Policy recommendation: Transfer of knowledge into clinical practice

Invest in several educational fronts: the public, medical school students and residents, continuing medical education (CME), diagnostic imaging ordering systems that embed clinical practice guidelines (e.g., web-based computer order entry systems), and continuous audit and feedback of performance to clinicians.

Policy appraisal:

- The impact of clinical practice guidelines on diagnostic imaging use is not clear and in some cases seems minimal.
- Successful transfer of knowledge about appropriate diagnostic imaging requires a cultural change and investments on many fronts.
- Medical schools and CME courses must emphasize the harms and benefits of diagnostic imaging while focusing on appropriateness in the investigation of patients' symptoms.
- The public should be more aware of the harms and benefits of intensive diagnostic imaging.
- Clinical practice guidelines and clinical prediction rules (e.g., the Ottawa Ankle Rules) should be vigorously disseminated and embedded into diagnostic imaging ordering systems.
- Feedback provided to clinicians about their patterns of ordering in relation to evidence-based guidelines and in comparison with their peers may increase awareness.

5. Policy recommendation: Health technology assessment

Support the Ontario Health Technology Assessment Committee (OHTAC), particularly for its recent and unique role in recommending field studies relating to diagnostic imaging technology. Submit an application for OHTAC to examine obsolete and substitution diagnostic imaging technologies.

Policy appraisal:

- Policy-based field evaluations, such as those recommended by OHTAC, should be encouraged to justify investment of time and resources provided for diagnostic imaging techniques for new indications.
- Examples of OHTAC field evaluations include 64-slice CT coronary angiography and positron emission tomography (PET) scanning.
- The marked rise in the use of new diagnostic imaging techniques has not met with corresponding decreases in obsolete technologies.

6. Policy recommendation: Provision of diagnostic imaging services by non-radiologists

Monitor trends in the ambulatory provision of imaging services by non-radiologists and involve key stakeholders in the creation of clear guidelines regarding self-referral.

Policy appraisal:

- Non-radiologists, particularly cardiologists, are performing diagnostic imaging in ambulatory settings because:
  - Technological advances are making it more feasible to operate diagnostic imaging equipment outside of large specialized centres;
  - The purchase and operation of diagnostic imaging equipment represents a way for clinicians to increase their own revenue, particularly if they are able to refer their own patients for imaging tests performed in facilities in which they have a financial interest (i.e., self-referral). Although this may increase patient convenience, patient safety and appropriateness of use may be in question; and,
  - There are currently no Ontario data describing trends in ambulatory provision of imaging services or the extent to which self-referral may be occurring.

Chapter 6: Conclusion

Conclusion

Innovations in diagnostic imaging technology continue at a rapid pace and may offer the potential for significant benefits to the health of Ontarians. Understanding appropriate use and ensuring the cost-effectiveness of diagnostic imaging are the greatest challenges to health care systems around the world. None of the examined health systems have tackled these challenges. Australia has the most advanced methods of managing diagnostic testing use, but a system evaluation has yet to be done. Ontario should embrace the current opportunity to develop the best methods of meeting these challenges, and should be prepared to rigorously evaluate their success in the coming years.

Appendices—Appendix A. How the Research was Done

Part I—Descriptive Analysis

Selected diagnostic tests

The testing patterns of diagnostic tests in Ontario were studied from 1996/97 to 2005/06. The following 31 tests were selected based on a combination of relative growth and/or absolute costs:

Ambulatory Electrocardiogram(ECG)—Holter monitoring

1. 24-hour Holter
2. 48-hour Holter
3. 72+-hour Holter
4. Any Holter monitoring

Cardiac investigations

5. Cardiac event loop monitor
6. Cardiac nuclear perfusion
7. Cardiac nuclear wall motion
8. Coronary angiography
9. Non-imaging stress test
10. Resting ECG

Computed tomography (CT)—stratified by body part

11. CT-abdomen/pelvis
12. CT-brain
13. CT-other
14. CT-spine
15. CT-thorax
16. CT-total

Echocardiography

17. Transesophageal echo
18. Transthoracic echo
19. Any echo

Nuclear bone scan

20. Nuclear bone scan

Magnetic resonance imaging (MRI)—stratified by body part

21. MRI-brain
22. MRI-extremities
23. MRI-other
24. MRI-spine
25. MRI-total

Sleep study

26. Sleep study (including sleep titration test)

Ultrasound

27. Abdominal U/S
28. Pelvic/intracavitary U/S
29. Pregnancy U/S

X-ray

30. Spine X-ray
31. Chest X-ray

Most tests were identified for outpatients only, since many inpatient tests are covered by hospital global budgets and would therefore not be reimbursed by the Ontario Health Insurance Plan (OHIP).

Data sources

Information about the number of tests performed was obtained from the OHIP claims database, which covers all reimbursement claims to the Ministry of Health and Long-Term care (MOHLTC) made by fee-for-service physicians, community-based laboratories and radiology facilities.

The Ontario Registered Persons Database (RPDB) contains demographic information (age, sex and postal code) for all residents who are eligible for health care in Ontario. This information was used for the age- and sex-specific analyses. The Statistics Canada Postal Code Conversion File was used to convert patients' postal codes to Local Health Integration Networks (LHINs) and to neighbourhood income quintiles to allow the study of variation in testing rate by region and by socioeconomic status.

The Statistics Canada 2001 Census, specifically the Ontario population files, was used to obtain population estimates for the years under study.

Analysis

For each diagnostic test, the following analyses were performed:

1. **Annual number of tests—**Tests were identified from selected OHIP fee codes using pre-specified algorithms from 1996/97 to 2005/06 (April 1, 1996 to March 31, 2006).
2. **Age and sex-specific rates of testing**—Patients' age, sex and postal code, as of April 1st in the fiscal year of the test, were obtained from the Registered Persons Database (RPDB). Rates were expressed per 100,000 population for 2005/06. The denominator for calculation of pregnancy ultrasound rates was women aged 15 to 54 years. Statistics Canada Census data for Ontario were used to adjust for age using defined age groups (0–19, 20–39, 40–64, 65–74, 75–84, 85+ years) and sex (male, female). For the year 2005/06, a medium growth population projection was used because the census update for 2005 was not available yet.
3. **Variation by LHIN**—Patients' postal code, as of April 1st in the fiscal year of the test, was used to assign them to the appropriate LHIN. Regional variation in the number, crude and age- and sex-adjusted rates per 100,000 population was determined.
4. **Variation by socioeconomic status**—Patients' postal code at the time of the test was also used to assign them to the appropriate neighbourhood income quintile (a measure of overall socioeconomic status). Socioeconomic variation in the number and age- and sex-adjusted rates per 100,000 population was determined.
5. **Number of repeated tests**—The percentage of patients who received one or more repeats of a given test, after an initial study, was calculated for 1996/97 and 2004/05. For each patient the first test within a fiscal year was identified for each diagnostic service. If a patient had another test within 365 days, it was considered to be a repeated test. This analysis was repeated using tests, rather than patients, as the unit analysis. **Temporal changes and geographic variation** in repeat testing were also analyzed.

In addition, the extent of **substitution of one test for another** (for two tests that provide similar information) was examined using cardiac nuclear wall motion and echocardiography as test cases from 1996/97 to 2005/06.

OHIP fee codes

Diagnostic tests were identified from OHIP fee codes. Wherever possible, professional (versus technical) fee components of OHIP billings were selected. For most studies, only one test per patient per day was allowed.

Table 1.1 Ontario Health Insurance Plan (OHIP) fee codes for sleep studies and sleep titration tests

OHIP fee code	Description
G671,G672, G674, G675, G677, G80, J690, J691, J692, J890, J891, J892, J893 J894	Sleep study
J689, J889	Sleep titration-therapeutic study for CPAP titration

Table 1.2 Ontario Health Insurance Plan (OHIP) fee codes for cardiac investigations

OHIP fee code	Description
G319	Non-imaging stress test
G313	Resting ECG
G297, Z442	Coronary angiography
J607, J608, J807, J808	MPS (myocardial perfusion scintigraphy)*
J604, J606, J611, J613, J667, J804, J806, J811, J813, J867	MUGA (multiple gated acquisition)*
J609, J666, J809, J866	SPECT (single photon emission computed tomography)*
G112	Dipyridamole thallium stress test*
G319	Stress test*
G650, G653, G656, G657, G685, G659, G690	Holter monitor (ambulatory ECG monitoring)**
G660	Cardiac event loop monitor

*Used to identify cardiac nuclear perfusion, cardiac nuclear wall motion and non-imaging stress test according to a defined algorithm.

**Used to identify 24-, 48- and 72+-hour Holter monitoring according to a defined algorithm.

Table 1.3 Ontario Health Insurance Plan (OHIP) fee codes for echocardiography

Fee code	Description
G561, G562, G567, G568, G571, G572, G575	Transthoracic echocardiography
G581	Transesophageal echocardiography

Table 1.4 Ontario Health Insurance Plan (OHIP) fee codes for ultrasound

Fee code	Description
J138, J161, J162, J163, J164, J165, J438, J461, J462, J463, J464, J476	Pelvic/intracavitary ultrasound
J128, J135, J428, J435	Abdominal ultrasound
J157, J158, J159, J160, J457, J458, J459, J460	Pregnancy ultrasound

Table 1.5 Ontario Health Insurance Plan (OHIP) fee codes for X-ray

Fee code	Description
X090, X091, X092	Chest X-ray
X025, X027, X028, X031, X032, X033, X034, X035, X202, X203, X204, X205, X206, X207, X208	Spine X-ray

Table 1.6 Ontario Health Insurance Plan (OHIP) fee codes for nuclear bone scan

Fee code	Description
J650, J651, J850, J851, Y650, Y651, Y850, Y851	Nuclear bone scan

Table 1.7 Ontario Health Insurance Plan (OHIP) fee codes for computed tomography (CT)

Body Part	OHIP Code	Description
Abdomen	X126, X409, X410	CT-abdomen
Extremities	X127, X412, X413	CT-other
Head	X188, X400, X401, X402, X405, X408	CT-head
Neck	X124, X403, X404	CT-other
Pelvis	X231, X232, X233	CT-pelvis
Spine	X128, X415, X416	CT-spine
Thorax	X125, X406, X407	CT-thorax

Table 1.8 Ontario Health Insurance Plan (OHIP) fee codes for magnetic resonance imaging (MRI)

Body Part	OHIP Code	Description
Abdomen	X451	MRI-other
Extremities	X471, X488	MRI-extremities
Head	X421	MRI-brain
Neck	X431	MRI-other
Pelvis	X461	MRI-other
Spine	X490, X492, X496	MRI-spine
Thorax	X441	MRI-other

Part II—Jurisdictional Review

Information for this jurisdictional report was gathered from peer-reviewed literature, using the combinations of the following search terms in the MEDLINE and EMBASE databases:

- Diagnostic imaging
- Magnetic resonance imaging
- Tomography, X-ray computed
- Utilization
- Policy making
- Public policy
- Health policy
- Financing, government
- Health planning
- Appropriate
- Inappropriate
- Utilization review

The search was limited to the English language. Experienced librarians and research staff also searched the grey literature (print and electronic) to identify other documents relevant to this report. Experts in different jurisdictions were contacted (see list of experts below) to obtain additional information using a structured questionnaire (see Appendix B).

List of experts contacted

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Data sources

Data sources that were used for the analysis of expenditures (health care and diagnostic services) across various jurisdictions included the Organization for Economic Co-operation and Development (OECD) Health Data 2006 edition[30] as well as "Quick Stats" from the Canadian Institute for Health Information.[31]

Appendix B. Structured Questionnaire for Jurisdictional Review Interviews

Experts in different jurisdictions were contacted to obtain additional information using the following structured questionnaire:

1. Funding Framework

- What level of government has jurisdiction over funding for diagnostic services?
  - Capital costs (machinery, etc.)
  - Operating costs
- What is the balance of private and public funding?
- How are physicians reimbursed for providing diagnostic services?

2. Legislation and Policy

- What pieces of legislation influence the delivery of diagnostic services?
- Do different policies exist for different settings in which diagnostic services are provided? Explain.
- Does regionalization play a role in how diagnostic services are provided/delivered? In what way?
- What role do regulatory bodies (e.g., colleges, associations, etc.) play in decision-making around diagnostic service provision?

3. Health Technology Assessment

- Is there a health technology assessment (HTA) organization mandated to make recommendations re: adoption/funding of diagnostic services?
- What is the process for approval?

4. Clinical Practice Guidelines

- Are there concerns (e.g., from payers and/or providers) about the appropriateness of the use of diagnostic services/imaging? If so, what is being done about it?
- Are there evidence-based guidelines in place for the appropriate use of diagnostic services/imaging?
- How do you encourage adherence? (e.g., audits, computerization, etc.)
- Is there assessment of adherence to guidelines?

5. Human Resources

- What are the training requirements for technicians?
- What are the most pressing issues with regard to:
  - Training and education;
  - Scope of practice; and,
  - Supply and demand of qualified professionals.

6. Models / Experiments

- Are there any new models being introduced or piloted in the delivery or funding of diagnostic services?

Appendix C: Summary of Health Systems in Various Jurisdictions

Jurisdiction	Summary of health insurance system
Canada	• Universal health services as dictated by the *Canada Health Act* 1982 which was enacted "to protect, promote and restore the physical and mental well-being of residents of Canada and to facilitate reasonable access to health services without financial or other barriers." (Section 3). • Ontario, Alberta, British Columbia and Quebec charge annual user premiums. Diagnostic, treatment and preventive services must be publicly administered, comprehensive in terms of services, universal across all people, portable across provinces, and accessible for all Canadians. There is also a requirement that the provinces must not accept extra billing or user charges; however, this has been called into question over the past decade. • The provinces receive federal transfer payment funding for the provision and management of health care as stated by the Act. • Each province has developed a schedule that outlines the services that will be publicly provided. • Patients are free to choose their own primary physician who typically acts as a 'gatekeeper' to specialist care and diagnostic tests. • Most physicians are paid through a fee-for-services (FFS) reimbursement plan by the province, however, some primary care physicians and specialist care is covered through alternate payment programs or through salary. • Hospitals are typically provided with global funding from provinces. • Most inpatient and some hospital outpatient diagnostic services are covered under this global funding, depending on the province and the hospital. • Diagnostic testing, such as X-ray or ultrasound, may be provided outside a hospital through publicly funded independent health facilities. • MRI and CT are typically provided in a hospital setting.
United States	• Private sector finances a large portion of health care. • Public health coverage is provided for elderly (Medicare) and low-income families (Medicaid). • Others rely on private health insurance (72% have private coverage through employer plans). • Health maintenance organizations (HMOs) monitor and provide for services. • Physicians are paid most commonly on an FFS basis but other remuneration models exist. • Hospitals typically receive case-based payments using a diagnosis-related group (DRG) system.[47] *Kaiser Permanente:* • A large, primarily privately-financed, HMO with 8.5 million enrollees, 6.3 million of whom live in California. • Medical practice groups funded through capitation and physicians are salaried; bonuses paid for meeting performance targets. • Decisions about capital investment made at the regional level, based on cost-benefit data by Interregional New Technologies Committee (INTC), and on the availability of a "critical mass" that would justify the adoption of the new technology. • Capital projects are funded through operating revenue.

Jurisdiction	Summary of health insurance system
United Kingdom	• Comprehensive and universal access to health care based on need rather than on the ability to pay through the National Health Service (NHS), financed through central government taxation. • The Department of Health sets the overall direction for the NHS and controls ten Strategic Health Authorities (SHAs) who are responsible for managing and supervising the system. • The Primary Care Trusts (PCTs) control 80% of the NHS budget, and are responsible for local operations. • Budgets based on local health need.[32,47-49] • General practitioners (GPs) are independent, self-employed contractors to the NHS, whereas hospital doctors are salaried employees of the NHS. • Payment for GPs is based on a national contract negotiated between GPs and the Department of Health, and is a mix of fixed allowances, capitation fees, incentive payments for performance, and FFS payment. • Full-time NHS consultants, or senior specialists, are permitted to earn up to 10% of their gross income from private practice. A duplicate private hospital and specialist care system exists in the UK, and approximately 10% of the population has private coverage.
France	• Blend of public and private financing; free health care for low-income persons and those with long-term illness. • Employed persons contribute to national health insurance according to their income. • About 80% of the population covered by the Caisse Nationale d'Assurance Maladie des Travailleurs Salariés (CNAMTS) through a system of 16 regional and 133 local sickness funds, managed by boards with representation from both employers and employees. • Physicians are paid directly by their patients on an FFS basis, even though part of the payment is reimbursed by the sickness funds. • Referrals are not needed for specialist visits. • About two-thirds of hospital beds are in the public sector, with the remainder split between the for-profit and not-for-profit private sectors. Public hospitals and private not-for-profit hospitals are financed by the sickness funds through global budgets. • Capital equipment is financed by global budgets allocated by the regional hospital agency.[32,45,46]
Germany	• A social health insurance system based on a principle of solidarity, such that economically stronger members of society support the weaker. • All health services are available to the entire population. • Membership in this Gesetzliche Krankenversicherung (GKV) system is compulsory with contributions based on income, with equal matching by employer. • Individuals above an income threshold may buy private insurance. • Physicians' associations assume responsibility for providing medical care in each region through a nationally-determined fee schedule. • Regional associations and sickness funds negotiate overall expenditure targets for ambulatory care budgets; the regional associations then distribute payment to individual physicians for services provided. • Hospital treatment covered by public systems, with operating costs being met by the sickness funds and payment now based on case-mix using a DRG methodology.[45]

Jurisdiction	Summary of health insurance system
Sweden	• Publicly funded universal health care in which overall health policy is set by the state and health care delivery is organized at the regional level. • Twenty-one county councils own and run the hospitals, health centres and other health institutions in their jurisdiction, and are responsible for deciding on resource allocation and service provision within their jurisdiction. • The councils are grouped into six larger regions responsible for highly specialized care. A majority of the operational budget of the county councils (89%) goes towards the provision of health services and is largely financed through taxation revenue. A small amount of county council revenue (4%) is from patient user fees for physician visits and inpatient hospital stays, the amounts of which are set by the individual county councils. There is a maximum annual cap for user fees, and children are not required to pay user fees. • Most system budgets and payments are made according to results or performance. • Hospitals receive a relatively high proportion of the total medical resources. • Public primary care physicians are salaried, whereas private GPs and private specialists are paid on an FFS basis by the county councils. Citizens are free to choose their provider and do not require a referral to see a specialist.[50]
Japan	• Citizens receive mandatory universal health insurance from either Employees' Health Insurance, which covers salaried workers and sets premiums proportional to income (half paid by the employee and half by the employer), or National Health Insurance, which covers workers in agriculture, forestry and fisheries, as well as self-employed and non-employed individuals. • Insurance premiums for National Health Insurance are also based on ability to pay. In addition, the government contributes a small amount of funding to these systems and is highly involved in health service regulation. • Despite this government involvement, service providers are privately paid by third-party insurers. • Patients pay 20–30% of hospital and outpatient costs. • Payments for outpatient services are mostly made on an FFS basis, whereas inpatient care is paid through a mixture of per diem payments and FFS payments. • There are concerns that the FFS system that pays physicians for each visit, as well as for each prescription or test that is ordered, may encourage quantity rather than quality of care.[51-53]

Jurisdiction	Summary of health insurance system
Australia	• Since 1984, Australia has had a national tax-financed public health insurance system called Medicare, which is available to all its permanent residents, and is the only means of coverage for outpatient physician services. • Within public hospitals, patients receive full coverage but do *not* have their choice of physician; however, they may elect to be treated as private patients so that they can choose their physician. In such cases, Medicare still covers the majority of in-hospital physician fees for private patients while the private health plans offer coverage for physician fees above and beyond the government subsidized amount. • Even in private hospitals, which typically provide uncomplicated elective surgery, Medicare still covers the majority of physician fees, and private health plans again offer a variety of coverage options for the remaining costs of hospitalization. • Physicians receive payment from Medicare for outpatient services almost exclusively on an FFS basis. Doctors are salaried for providing care to public inpatients, whereas physicians receive payment on an FFS basis for private inpatients (partly from Medicare and partly from private health plans). • Public hospitals are jointly funded by the Commonwealth and the States, with the States being responsible for their administration, and determining levels and conditions of funding public hospitals. • Most private hospitals have contracts with private health funds that set out the levels of benefits to be paid. If no contract exists, then benefits are paid at default rates set by the government.[47,81] • The schedule of benefits is managed by the Australian Department of Health and Ageing, and outlines the fees payable by Medicare for outpatient diagnostic imaging services.

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