The Conference Board of Canada

The Value of Radiology, Part II

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Preface

This research was conducted to calculate the economic costs associated with excessive wait times for CT and MRI diagnostics and to forecast the replacement costs for medical imaging equipment in Canada between now and 2040. Our results show that excessive wait times for radiology services cost the Canadian economy $3.54 billion in lost productivity in 2017 and that the replacement costs to modernize Canada's medical imaging equipment are $4.4 billion between now and 2040.

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Executive summary

Key findings

- Excessive wait times for CT and MRI diagnostics cost the economy $3.54 billion in 2017.
- Approximately 5 per cent of patients, or 380,000 people a year, are forced to exit the workforce temporarily while they wait longer than the recommended maximum wait time.
- Having workers off the job while waiting for diagnostics hurts the ability of firms to produce goods and services. This, in turn, hurts GDP, reducing government revenues by $430 million a year.
- The cost of excessive wait times will likely increase. Growth in demand for CT and MRI services is expected to outpace the growth in supply over the long term.
- Currently, 151 new CT machines and 91 new MRI machines are required to modernize Canada’s stock of medical imaging equipment, at a cost of $469 million.
- Total investment in acquiring imaging machinery needed to meet demand and in keeping the machines up to date with the latest technology amounts to $4.4 billion over the next two decades.

This is the second report released by The Conference Board of Canada on the value of radiology in Canada. The previous report looked at key aspects and services provided by the Canadian radiology sector, demonstrating the importance of radiology to Canadian health care and regional economies. This report evaluates current wait times for radiological procedures and the future demand and supply of medical imaging equipment.

Excessive wait times bring with them a host of negative consequences. They can worsen the health outcomes for patients, of course. But they also create economic inefficiencies by forcing patients to take time away from work, hurting the ability of firms to produce goods and services, and reducing overall economic output.

The impact of excessive wait times is particularly high for patients who are waiting for medically necessary imaging diagnostics, which are often required prior to receiving further treatment. Computed tomography (CT) and magnetic resonance imaging (MRI) diagnostics are used for many medical conditions and play an integral role in the treatment of patients in Canada's health system. While the benefits of ensuring timely access to imaging diagnostics are clear, many Canadian patients wait longer than recommended due to insufficient capacity, patient backlogs, and inconsistent access to specialist treatment.

The three main costs associated with a delay in medical imaging scanning are patient costs, caregiver costs, and health system costs. This analysis focuses on the first of the three—patient costs. "Patient costs" are defined here as the estimate of the economic activity that is lost while patients wait for treatment; in other words, loss of output in the economy resulting from patients having to stop working while waiting for treatment.

We arrived at two major conclusions. First, excessive wait times for CT and MRI diagnostics result in billions of dollars in lost economic output per year. Second, major investments in CT and MRI equipment will be required to modernize the supply over the long term to cope with an aging population.

These results are concerning, both for radiologists and for patients. Radiologists are having to use mostly out-of-date equipment to treat and diagnose patients. At the same time, they must cope with large increases in demand for their services. For patients across Canada, the shortage of equipment means that they often face longer-than-recommended wait times and the possibility that they will be forced to leave the workforce temporarily while they wait for diagnosis. And those are just the direct impacts. Every Canadian is indirectly affected by excessive wait times because the resulting reduction in economic output leads to lower government revenues, which means less money available for governments to use for the providing of social and other services to Canadians.

The costs to the Canadian economy of an inadequate supply of medical imaging equipment are distributed unevenly across Canada. In Western Canada, per-patient costs to the economy are higher than in Central and Atlantic Canada, largely because of differences in weekly earnings. There are also differences among the provinces in the maximum recommended wait times for CT and MRI diagnostics, differences that can have an impact on patient outcomes.

The overall economic costs of these long wait times are likely even higher than estimated in this report. Due to data limitations, our analysis did not estimate the impact of the lower productivity within our health care system that is due to long wait times or the additional costs incurred by caregivers. It is reasonable to assume that national wait-time costs would be higher if these factors were incorporated into this analysis.

While this report uses publicly available wait times data, a more thorough analysis of these issues would be possible if all the provinces had more detailed information on patient wait times. Improved data collection could lead to more effective health care policy in Canada and further help to address the challenge of excessive wait times and the distribution of medical imaging equipment.

In response to long wait times that will continue to increase through 2040, we recommend that governments in Canada make investments in medical imaging equipment a major priority. Currently, much of Canada's medical imaging equipment is out of date and no longer meets international standards of health service excellence. This suggests that delaying the much-needed investment in this equipment can only make the current situation worse over the forecast period as demand for the services continues to surge due to an aging population.

Governments in Canada should make investments in medical imaging equipment a major priority.

Chapter 1

Introduction

Excessive wait times bring with them a host of negative consequences. They can worsen the health outcomes for patients, of course. But they also create economic inefficiencies by forcing patients to take time away from work, hurting the ability of firms to produce goods and services, and reducing overall economic output.

The impact of excessive wait times is particularly high for patients who are waiting for medically necessary imaging diagnostics, which are often required prior to receiving further treatment. Computed tomography (CT) and magnetic resonance imaging (MRI) diagnostics are used for many medical conditions and play an integral role in the treatment of patients in Canada's health system. While the benefits of ensuring timely access to imaging diagnostics are clear, many Canadian patients wait longer than recommended due to insufficient capacity, patient backlogs, and inconsistent access to specialist treatment.[1]

Some patients requiring medically necessary procedures are unable to work while waiting for treatment. This contributes to weaker output in the economy. Not only are these patients at an economic disadvantage due to their inability to work, they are also likely to suffer worse health outcomes. CT and MRI diagnostics are used to detect a wide range of conditions. Some of these diagnostics, however, are paired with procedures to treat patients with severe illnesses, such as cancer.[2] Early detection for various conditions strongly influences patient health outcomes, often leading to improved results for those patients who receive treatment within the recommended time frame.

Long wait times for radiological services are connected to the supply and utilization of medical imaging equipment. The amount of active equipment determines the rate at which patients receive medical imaging diagnostics. A well-supplied and up-to-date stock of imaging equipment helps to reduce patients' radiation dose at the time of imaging. It improves patient outcomes and generally leads to shorter wait times for patients seeking radiological procedures and services. In Canada, there have been concerns about both the availability of medical imaging equipment and the outdated state of many of the devices currently being used. These concerns relate to the increased demand for radiological services and an aging population that requires a disproportionate share of imaging diagnostics.

This is the second report released by The Conference Board of Canada on radiology's value to Canada. The previous report discussed key aspects and services provided by Canada's radiology sector, demonstrating its importance to our health care system and economy. This report evaluates current wait times for radiological procedures and the future demand and supply of medical imaging equipment.

The report is divided into two sections. The first estimates the economic costs associated with wait times for CT and MRI procedures. The second forecasts the future demand for and supply of CT and MRI devices in Canada.

1 Canadian Institute for Health Information, "Commonwealth Fund Survey 2016."

2 Canadian Association of Radiologists, *CAR Practice Guidelines and Technical Standards for Breast Imaging and Intervention.*

Chapter 2

The impact of excessive wait times

The role of diagnostic exams

Two common diagnostic exams performed in Canada are CT and MRI scans.[1] These diagnostic exams are often mandatory for patients with severe health conditions and are widely recommended for patients requiring additional treatment.

Radiological services are carried out by various specialists, with the goal of providing, in as timely a manner as possible, medically necessary imaging diagnostics. These providers include diagnostic radiologists, interventional radiologists, medical radiation technologists, sonographers, medical physicists, and nuclear medicine specialists. Each specialty contributes to servicing patient needs for accurate medical diagnostics.

CT exams are a form of non-invasive X-ray tests that scan patients for internal abnormalities. They are commonly used to triage patients based on distinct medical characteristics, to detect many types of cancers, and for the internal visualization of injury. Not surprisingly, given their versatility and effectiveness, the number of publicly funded CT exams increased by 75 per cent between 2007 and 2017, rising to approximately 5.6 million unique procedures annually.[2]

MRI exams are similar to CT exams. However, they use magnetic resonance technology to visualize internal abnormalities. This difference in technology leads to superior tissue contrast, which enables the diagnoses of some diseases that are not well assessed with CT technology. MRI exams take longer than CT exams to process. As a result, there are fewer MRI exams conducted per year. In 2017, 1.86 million MRI exams were performed in Canada, up from 1 million in 2007.[3] Some common applications of MRI technology include the investigation and staging of cancer (e.g., rectal, breast), brain disease, abdominal organs and joints, neuro and musculoskeletal abnormalities, muscle tumors, and the assessment of cardiac structure and function.

These exams have been identified, in association with the Canadian Association of Radiologists, as priority areas. Excessive wait times for each procedure lead to worse patient outcomes and force some patients to forgo their normal economic activities. Although the share of patients that are adversely affected while waiting for treatment is low, the total number of patients affected is expected to increase due to the growing number of radiological exams performed each year.

Recommended maximum wait times

Wait times for health services result from a discrepancy between the amount of services that are being supplied and the level of demand

1 Canadian Agency for Drugs and Technologies in Health, “Overall Findings.”

2 Canadian Agency for Drugs and Technologies in Health, “Computed Tomography.”

3 Canadian Agency for Drugs and Technologies in Health, “Magnetic Resonance Imaging.”

for these services. Simply put, when there is more demand for health services than can be met with the available supply, a queue forms and patients must wait for treatment.

Wait times are problematic for all parties involved. For patients who are waiting for treatment, delays increase the time for recovery and can lead to worse health outcomes (depending on the type of treatment required). Some patients waiting for medically necessary care are unable to continue working and, thus, they stop contributing to the economy.

Optimal wait times are highly subjective and can be affected by factors such as physician workload, condition urgency and prioritization, health resource management, and variable health services demand.[4] For our analysis, we favoured recommended maximum wait times over optimal wait times. This metric allows for greater resource flexibility and is based primarily on health care utilization, provincial capacity, priority levels, and the nature of a procedure. Critics have argued that some maximum recommended wait times place too much pressure on provincial health ministries with lower capacity for treatment. But proponents generally say that maximum recommended times are purely suggested times to consider and represent an ideal scenario as prescribed by practising physicians.

The only standardized maximum recommended treatment time for radiological diagnostics is for radiation therapy. While data are collected for CT and MRI procedures across most provinces, there has yet to be an agreed-upon national standard for wait times. This is important because it means that patients in different provinces receive treatment using different standards of care. This might explain, at least in part, the large variation in wait times for radiological services in Canada. However, proponents of maximum recommended wait times believe that setting national wait-time benchmarks for more radiological services could assist in standardizing the patient experience across Canada.

While all patients wait some amount of time for medically necessary procedures, some patients wait much longer than others for the same treatment. Due to this discrepancy, various organizations and provincial ministries have developed wait-time benchmarks for physicians to consider. The Canadian Association of Radiologists (CAR)[5] and the Wait Time Alliance (WTA)[6] have published recommended wait times for radiological services in Canada based on priority levels and provincial capacity for treatment. (See Table 1.) Wait-time benchmarks for key medical procedures have also been set in collaboration with the Canadian Institute for Health Information (CIHI)[7] and various provincial agencies. Recommended wait times support patients by setting standards for treatment times and support medical officials in ensuring timely access for care.

4 Centre for Spatial Economics, The, *The Economic Cost of Wait Times in Canada*.

5 Canadian Association of Radiologists, *National Maximum Wait Time Access*.

6 Wait Time Alliance, “Radiology: Wait Time Benchmarks.’

7 Canadian Institute for Health Information, “Benchmarks for Treatment and Wait Time.”

Recommended wait times set standards for treatment times and ensure timely access for care.

Table 1

Pan-Canadian MRI and CT wait-time benchmarks

Priority definition	Maximum time recommended
Priority 1 (P1) Emergent: An examination necessary to diagnose and/or treat injury that is immediately threatening to life or limb.	P1: Same day—maximum 24 hours.
Priority 2 (P2) Urgent: An examination necessary to diagnose and/or treat disease or injury that is not immediately threatening to life or limb.	P2: Maximum seven calendar cays.
Priority 3 (P3) Semi-urgent: An examination necessary to diagnose and/or treat disease or injury where clinical information requires the examination be performed sooner than for P4.	P3: Maximum 30 calendar days.
Priority 4 (P4) Non-urgent: An examination necessary to diagnose and/or treat disease or injury based on provided clinical information—no negative long-term medical outcome related to delay in treatment is expected for the patient if the examination is completed within the benchmark period.	P4: Maximum 60 calendar days.

Sources: Canadian Association of Radiologists; Wait Time Alliance.

Estimating the cost of excessive wait times

Once a recommended maximum wait time has been identified, wait-time costs can be calculated by estimating patient costs, caregiver costs, and health system costs.[8] To arrive at our methodology, we considered the body of international literature. There have been several international studies, including some that focus primarily on the return-on-investment propositions resulting from the need for increased health care resources. There have been several Canadian studies that have looked at the costs of wait times, including an annual report from the Fraser Institute on wait-time costs.[9] However, the most relevant research is found in two reports by the Ontario-based Centre for Spatial Economics (C4SE) on the economic cost of wait times in Canada. The C4SE conducted cost-analysis research for the Canadian Medical Association in 2006 and 2008, looking at the wait-time costs associated with various treatments, including MRI procedures. In its 2008 report, the centre estimated wait-time costs at $14.8 billion for joint

8 Centre for Spatial Economics, The, *The Economic Cost of Wait Times in Canada*.

9 Barua and Hasan, *The Private Cost of Public Queues.*

replacement surgery, cataract surgery, CABG surgery, and MRI exams. MRI exams accounted for $13.8 billion of that total.[10]

The three main costs associated with a delayed medical imaging scan are patient costs, caregiver costs, and health system costs. Our analysis focuses on the first of these three—patient costs. Patient costs are an estimate of the reduction in economic activity while patients wait for treatment—in other words, the output growth in the economy that is lost due to patients having to stop working while waiting for treatment.

Many patients suffer lost wages due to their inability to work, and that is a direct cost to them. But there is also a cost when those waiting for treatment continue to draw their salary while off work, as their employers lose their services for that time they cannot work. Regardless of whether the cost falls on the individual, in the form of lost wages, or on the employer, in the form of salary paid to an employee not working, the economic cost is the lost production caused by the patient being out of work longer than necessary. In both cases, this is measured by examining wages for those requiring treatment. Patient costs are estimated by simply multiplying the number of excess weeks a patient waits for an imaging test or procedure by average weekly earnings. We use the following formula:

> *Patient costs = (adjusted weekly earnings) x (weeks waited by financially affected patients)*

The total number of weeks that patients should wait for treatment is estimated from various data sources. The first source is the recommended maximum wait time for treatment. A higher recommended maximum will lead to lower cost estimates, while a shorter recommended time will lead to higher cost estimates. Another consideration is that recommended wait times have not been made official at the national level for CT and MRI exams. Each provincial health agency has set different benchmarks. As well, the Canadian Association of Radiologists and CIHI have set their own wait times. Given that there are no standardized times, results can vary when choosing specific recommended maximums. Some provinces have recommended maximums that are much higher than those set by other provinces. Shorter standardized benchmarks improve wait-time optics for provinces with higher health system capacity but worsen the situation in provinces with weaker capacity. Because of this, some provinces benefit from a standardized estimate while others do not.

The economic cost is the lost production caused by the patient being out of work longer than necessary.

10 Ibid.

The second data source is the median wait time, which is the number of days waited at the 50th percentile. (Using the median number of days is preferred to the average due to the presence of outliers in most provincial data sets.) The next step is to determine whether patients at the median are waiting longer than recommended by subtracting the maximum recommended wait time from the median. A positive value indicates that patients are waiting longer than recommended, while a negative value suggests that most patients are receiving treatment within the maximum recommended wait time. The formula looks like this:

Excess wait time + median wait time – maximum recommended wait time

Based on this formula, some jurisdictions will have higher values than others. All jurisdictions, however, have some proportion of patients waiting longer than recommended for treatment. It is therefore critical to determine the patient wait-time distribution by percentile. Weighted averages, based on the Alberta Health Service data set, are applied to calculate the average number of days waited above the recommended maximum. This is achieved by collecting data on the distribution of wait times that exceed the maximum recommended time. For example, 25 per cent of patients might wait eight months for treatment, another 25 per cent wait 10 months, and the remaining 50 per cent wait 13 months. These values can be weighed against one another to determine the average number of days. This value represents the expected number of days that the average patient will wait above the maximum recommended time.

The number of patients waiting longer than recommended is then multiplied by the share who are unable to participate in their usual economic activities, as in the following formula:

Queue = proportion waiting above maximum recommended time x share unable to participate in usual economic activities

This value is relatively straightforward to calculate but relies on accurate data by wait-time distribution. Because of this, the Alberta Health Services Database is used. This data set includes patient wait times by precise time intervals and also includes the share of patients in each time interval. As such, the proportion waiting longer than recommended can be determine by identifying the proportion of patients in time intervals above the maximum recommended time for treatment.

Moreover, this result allows us to calculate the number of patients unable to participate in their usual economic activities. This is then multiplied by the average number of days waited above the maximum recommended time, and then converted into weeks. The last step in the methodology is to multiply the total number of weeks by adjusted weekly earnings, as follows:

Patient costs = total weeks x (weekly earnings x labour force participation rate x (1-unemployment rate))

Chapter 3

Economic impact of excessive wait times for CT and MRI diagnostics

As discussed in the previous chapter, long wait times lead to lower economic production as some patients who require diagnostics must leave the workforce while waiting for diagnosis or treatment. In addition to the reduced output in the economy, this chapter also looks at the indirect and induced GDP impacts and lower government revenue caused by excessive wait times.

National patient costs

This section highlights cost estimates at the national level, which are equivalent to the reduction in production of the Canadian economy. The per-patient direct impact on GDP is shown in Chart 1. To ensure appropriate representation, values have been population-adjusted.

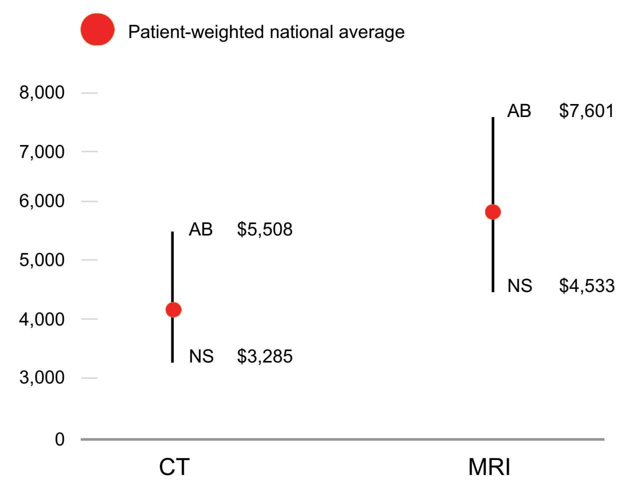
Nationally, excessive wait times for CT diagnostics cost the Canadian economy approximately $4,136 per patient. For MRI diagnostics, the cost rises to $5,853. Alberta and Nova Scotia represent the extremes, with Alberta at the top in costs on a per-patient basis and Nova Scotia at the bottom.

Per-patient average costs shown in Chart 1 are particularly concerning when paired with the thousands of Canadians who are forced to stop working while waiting for their tests. Our estimates indicate that roughly one in 20 patients seeking either CT or MRI diagnostics will have to forgo their regular earnings while waiting for treatment.

Chart 1

Average cost per patient financially affected

(direct GDP per patient, 2017 $)



Source: The Conference Board of Canada.

In 2018, approximately 262,855 patients waited an average of 50 days for CT diagnostic, while 117,045 patients waited an average of 69 days for MRI diagnostics. After considering weekly earnings, labour force participation, and the unemployment rate, the total patient costs for CT and MRI examinations is $1.78 billion. (See Chart 2.) Although CT scans cost less per patient than MRIs, their total economic impact is larger, at $1.11 billion (compared with $680 million for MRIs), because there are more of them.

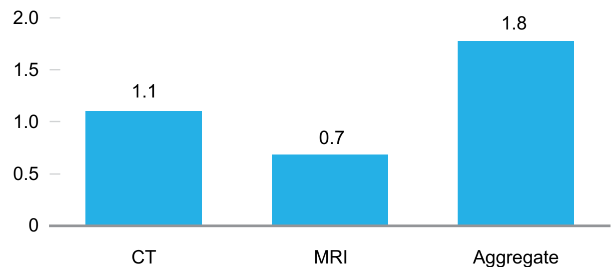
While the direct impact on the Canadian economy of $1.78 billion is significant, the total cost is nearly double that, at $3.54 billion, once the indirect and induced GDP impacts are included. While the direct impact includes the effect of reduced employment due to excessive wait times, the indirect and induced effects include the costs of other supply chain impacts and consumer spending resulting from the reduced output.

At the national level, the indirect impact on GDP of CT wait times is $630 million. For MRI wait times, the total is $390 million. The induced GDP measurements are comparatively lower, but still large at $450 million for CT waits and $280 million for MRI waits. Combined, the loss in national economic output associated with excessive wait times for CT and MRI procedures effectively doubles when adjusted to include indirect and induced impacts. Provincial and federal tax revenues are also hurt by the reduction in economic output. Our analysis shows that excessive wait times for CT and MRI procedures cost the federal and provincial governments $430 million in lost revenue. The overall impact on the Canadian economy is shown in Chart 3.

Chart 2

Direct impact of excessive wait times costs $1.8 billion

(2017 $ billions)

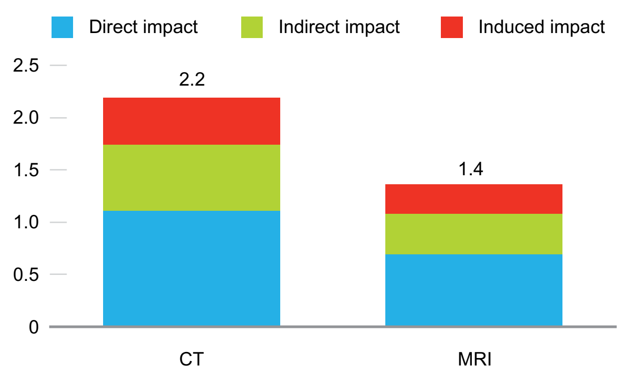


Source: The Conference Board of Canada.

Chart 3

Excessive wait-time impact on Canadian economy: direct + indirect + induced

(2017 $ billions)



Source: The Conference Board of Canada.

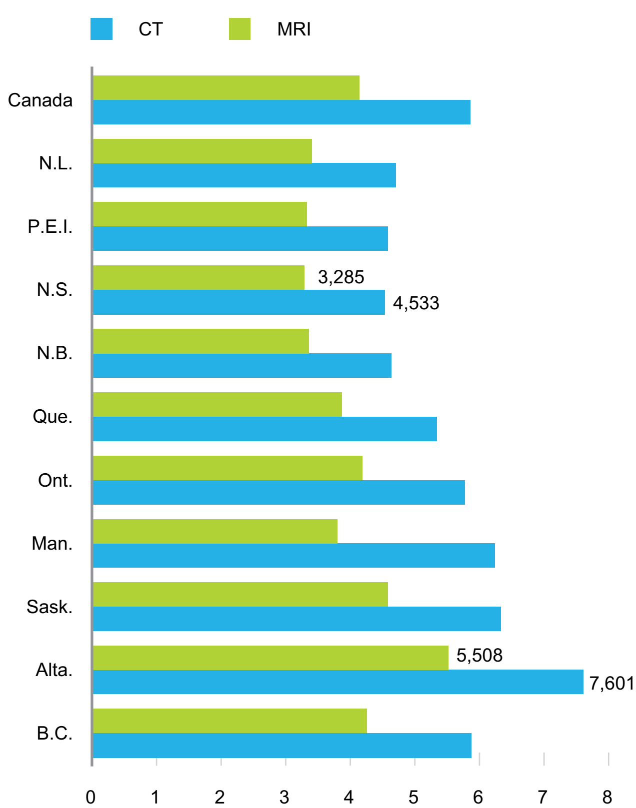
Provincial patient costs

This section highlights per-patient costs and aggregate costs by province. The focus is mainly on per-patient costs that have been adjusted to account for differences in provincial populations. The estimated direct GDP effect, indirect and induced impacts, and reduced government revenues are also broken down by province to show provincial variations in the results. The direct GDP impact, including the Canadian average, is shown in Chart 4.

Chart 4

Per-patient impact on the provincial economies

(annualized per-patient cost, 2017 $ 000s)



Source: The Conference Board of Canada.

Across Canada, per-patient wait-time costs for MRI diagnostics are higher than for CT diagnostics. The differences between the two are similar across the provinces. When it comes to the variation from the national average, there are no provincial outliers that are clearly far below or far above the national average for per-patient wait-time costs. For CT diagnostics, Manitoba, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador are below the national average, while British Columbia, Alberta, Saskatchewan, and Ontario are above the average. For MRI diagnostics, Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador are below the Canada-wide average, while British Columbia, Alberta, Saskatchewan, and Manitoba are above the national average.

Some of the variation in provincial per-patient costs can be explained by the differences in average weekly earnings. In general, provinces such as Alberta with higher average weekly wages have higher per-patient costs for both MRIs and CT scans. The rest of the variation is due to differences in wait times across the provinces. However, this analysis used the Alberta data set to estimate the distribution of wait times in provinces where it was unavailable. This is a data limitation, as some provinces with higher or lower actual wait times may look better or worse if their distribution is materially different. (See Table 2.)

Across Canada, per-patient wait-time costs for MRI diagnostics are higher than for CT diagnostics.

Table 2

Per-patient costs by province

($)

	CT	MRI
B.C.	4,253	5,869
Alta.	5,508	7,601
Sask.	4,584	6,326
Man.	3,800	6,232
Ont.	4,181	5,770
Que.	3,867	5,336
N.B.	3,353	4,628
N.S.	3,284	4,533
P.E.I.	3,323	4,584
N.L.	3,403	4,697
Canada	4,136	5,853

Source: The Conference Board of Canada.

Table 3

Total patient costs/direct GDP impact

($ millions)

	CT	MRI
B.C.	160.6	55.4
Alta.	106.4	111.3
Sask.	30.2	15.2
Man.	38.4	40.8
Ont.	428.7	271.1
Que.	250.2	152
N.B.	28.7	11.1
N.S.	28.3	18.1
P.E.I.	2.9	1.7
N.L.	12.9	8.2
Canada	1,107.60	687.8

Source: The Conference Board of Canada.

By total value, the provinces with larger populations have larger estimates of reduced output. Ontario and Quebec, therefore, have the largest dollar amounts associated with reduced production, while the provinces of Atlantic Canada have the smallest. The total impact on GDP by province is shown in Table 3.

Table 4

Direct + indirect GDP impact

($ millions)

	CT	MRI
B.C.	251.3	86.7
Alta.	166.5	174.2
Sask.	47.3	23.8
Man.	60.1	63.9
Ont.	670.9	424.3
Que.	391.6	237.9
N.B.	44.9	17.4
N.S.	44.3	29.8
P.E.I.	4.5	2.7
N.L.	20.2	12.8
Canada	1,733.4	1,076.4

Source: The Conference Board of Canada.

When the analysis is unadjusted for population, there are some interesting results. Because the proportion of patients waiting longer than recommended for MRI diagnostics is higher in Alberta than in British Columbia, the total impact on GDP is much larger despite the fact that both provinces share relatively similar population sizes.

As with the direct impact estimates, differences in provincial populations have a large impact on the variations in indirect and induced effects, which explains why the indirect impacts are larger in Ontario and Quebec than they are in Prince Edward Island and Newfoundland and Labrador, for example. Direct, indirect, and induced GDP impacts are shown in tables 4 and 5.

Table 5

Direct + indirect + induced GDP impact

($ millions)

	CT	MRI
B.C.	317.1	109.4
Alta.	210.1	219.8
Sask.	59.6	30.0
Man.	75.8	80.6
Ont.	846.4	535.3
Que.	494.0	300.1
N.B.	56.7	21.9
N.S.	55.9	35.7
P.E.I.	5.7	3.4
N.L.	25.5	16.2
Canada	2,186.9	1,358.0

Source: The Conference Board of Canada.

Table 6

Lost government revenues

($ millions)

	CT	MRI
B.C.	31.4	10.8
Alta.	13.3	13.9
Sask.	5	2.5
Man.	9	9.6
Ont.	101.5	64.2
Que.	77.8	47.3
N.B.	7.1	2.8
N.S.	7.4	4.7
P.E.I.	0.9	0.5
N.L.	2.9	1.8
Canada	266.5	165.5

Source: The Conference Board of Canada.

The reduction in wages and output from excessive wait times also have a cost to governments in the form of lower tax receipts. Table 6 shows the impact of excessive wait times on provincial and federal government revenues. The loss of tax revenues is highest in Ontario and Quebec, and lowest in the Atlantic region. Specifically, tax revenues in Ontario are estimated to be $101.5 million lower due to excessive waits for CT scans and $64.2 million lower due to excessive waits for MRI scans. As shown in the previous tables, the results for Alberta and Manitoba are outliers in the analysis. Because of relatively worse wait times and higher per-patient costs for Albertans and Manitobans seeking an MRI, their losses in tax revenues are higher for MRI wait times despite there being more CT scans carried out in both provinces.

Patient analysis

As previously stated, the estimates used in this analysis lead to the conclusion that roughly one in 20 patients seeking either CT or MRI diagnostics will have to discontinue their normal economic activities because of excessive wait times. At the national level, 4.7 per cent of CT patients and 6.3 per cent of MRI patients are expected to lose weekly earnings while waiting for treatment. (See Table 7.)

Patients seeking CT diagnostics are most likely to be economically affected if they live in New Brunswick, Nova Scotia, Prince Edward Island, British Columbia, or Manitoba. For MRI diagnostics, patients are most likely to be affected if they live in Nova Scotia, Prince Edward Island, Newfoundland and Labrador, Alberta, or Quebec.

Table 7

Number of patients economically affected per 1,000

	CT	MRI
B.C.	54	54
Alta.	47	76
Sask.	51	54
Man.	54	84
Ont.	42	54
Que.	48	76
N.B.	59	54
N.S.	54	84
P.E.I.	54	84
N.L.	42	84
Canada	47	63

Source: The Conference Board of Canada.

There is more variation in terms of how patients are affected by excessive wait times for MRIs. Patients in Atlantic Canada are generally more likely to face longer wait times and to be hurt financially. Patients seeking MRI diagnostics in Nova Scotia, Prince Edward Island, and Newfoundland and Labrador have an 8.4 per cent likelihood of being negatively affected while waiting for treatment. Almost one in 10 patients seeking MRI diagnostics in these provinces will lose wages due to wait times.

Chapter 4
Forecasting the need for medical imaging equipment

The patient experience is intricately connected to the availability of health care resources, including medical imaging equipment.

A well-supplied and -equipped health workforce is capable of meeting patient demand while avoiding resource overextension. In contrast, poorly equipped health workers are more likely to experience burnout and, due to overuse, their equipment doesn't last as long as it should. For patients, a well-supplied health workforce is important because it reduces wait times and improves patient outcomes.

This analysis focused on medical imaging diagnostic equipment with the goal of forecasting the demand for imaging diagnostics and the supply of imaging equipment over the next 20 years. The results provide valuable information on how quickly growth in demand will rise over the forecast and what type of investments in imaging equipment will be necessary to meet this demand.

Methodology

Data from *The Canadian medical imaging inventory, 2017* report were used to forecast the supply and demand for radiological equipment in Canada.[11] These data show where medical imaging equipment is located in Canada and how it is being used. The information is valuable because it helps public health planners and organizers to identify shortcomings in the distribution of medical imaging equipment across Canada.

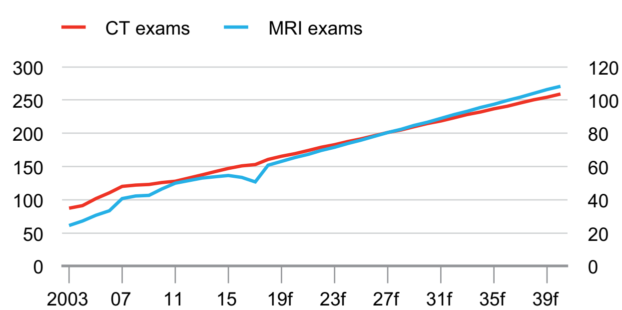
Forecasting demand for medical imaging services

The demand for CT and MRI services is based on population growth and the number of exams required on a per capita basis. The population estimates are based on the Conference Board's in-house demographic forecast model, which suggests that population growth will decelerate to less than 1 per cent annually but that the population will, nevertheless, exceed 43.6 million by 2040. The number of exams required per patient is projected using estimates of the historical relationship between population and the number of CT and MRI exams, both of which have trended upward over history and are expected to continue to do so over the forecast. (See Chart 5.)

Chart 5

CT and MRI exams per 1,000 population

(number of exams)



f = forecast

Sources: The Conference Board of Canada; CADTH; CIHI.

11 Canadian Agency for Drugs and Technologies in Health, *The Canadian Medical Imaging Inventory, 2017.*

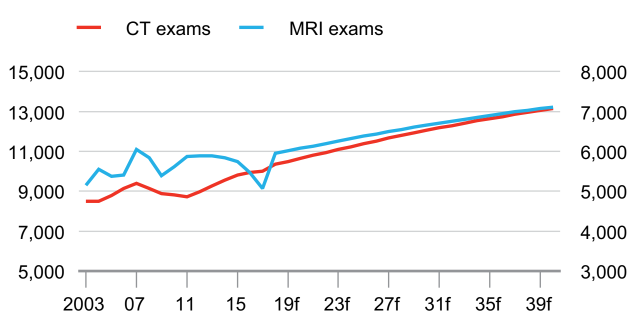
The upward trend is not surprising given Canada's aging population. More than one-third of diagnostic procedures today are done on patients aged 65 or over despite this cohort representing just 17 per cent of the population. And the 65-and-over population is growing by almost 4 per cent per year.

After determining demand for CT and MRI exams, we can project the number of units required based on our estimate of the number of exams that will be required in the future and the expected number of exams that each unit will complete. The number of exams per unit is projected in the same manner as exams per capita—that is, the increase in the number of exams per unit is projected forward based on historical trends. As shown in Chart 6, the number of exams performed each year by a CT machine is projected to grow from 10,000 in 2017 to 11,200 in 2040, while the number of exams by an MRI machine increases from 5,100 in 2017 to 6,400 in 2040.

Chart 6

CT and MRI exams performed per unit

(000s)



f = forecast
Sources: The Conference Board of Canada; CADTH; CIHI.

Forecasting supply for medical imaging equipment

The future supply of medical imaging units in Canada is projected based on the assumption that trends in medical imaging machine growth for the period 2000–17 holds constant over the forecast period.

While we use the average trend over the 2000–17 time frame, growth in the supply of CT and MRI equipment has changed significantly over the past few decades. In the early-to-mid-2000s, the net number of new machines added to supply each year was on an upward path. Since then, however, annual growth in the supply of medical imaging equipment has weakened sharply. In 2010, trend growth in the total number of CT machines peaked at 20 units per year. (See charts 7 and 8.) By 2017, CT trend growth had fallen to about 13 units per year.

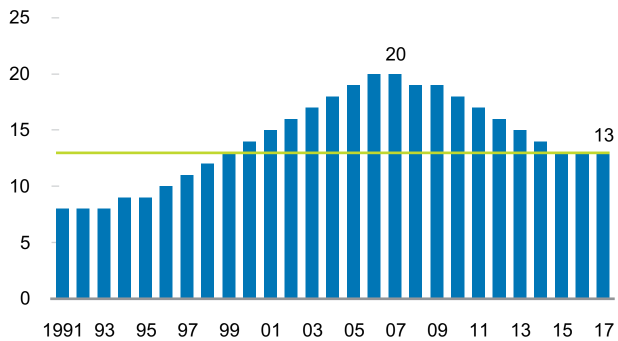
Similarly, trend growth in the total number of MRI machines peaked at 17 new units from 2005 to 2009. (See charts 9 and 10.) MRI trend growth had dropped to about 13 units per year by 2017.

Over the projection period, we assume that the net addition to CT and MRI stocks will equal 13 units each year, in line with historical increases.

Chart 7

New CT machines at an 18-year low

(net addition to stock, units)

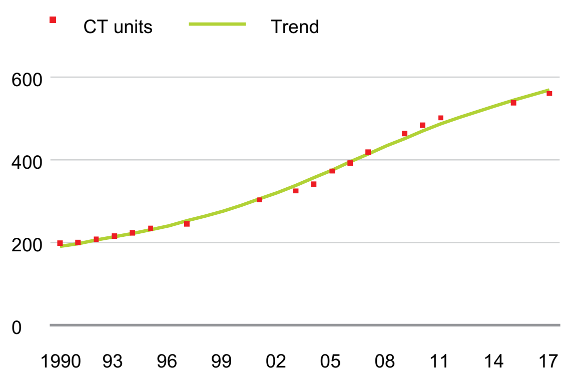


Sources: The Conference Board of Canada; CADTH; CIHI.

Chart 8

Stagnant growth trend in CT units

(total stock, units)

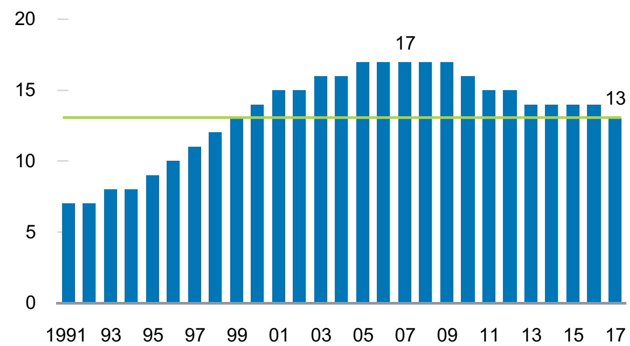


Sources: The Conference Board of Canada; CADTH; CIHI.

Chart 9

Number of new MRI machines falling

(net addition to stock, units)

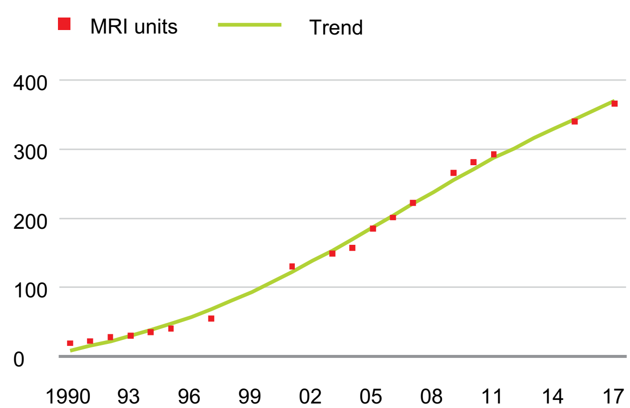


Sources: The Conference Board of Canada; CADTH; CIHI.

Chart 10

New MRI units trend slowing

(total stock, units)



Source: The Conference Board of Canada.

Forecasting additional units required to meet international standards for average machine age

A second part of forecasting the number of new units required is determining how much additional equipment would need to be purchased in order to bring the average age of Canada's medical imaging equipment up to, and then maintained at, international standards as defined by the "Golden Rules of Medical Imaging Equipment" developed by the European Coordination Committee of the Radiological, Electromedical and Health IT Industry.[12] These golden rules have been cited by the Canadian Agency for Drugs and Technologies in Health (CADTH) as one measure to "evaluate medical equipment age and aid procurement decisions, creating an age profile to balance keeping equipment current with the need to maintain efficient health care systems."[13] There are three golden rules used when assessing the capacity of medical imaging stock to meet the demands of the health care system:

- At least 60 per cent of imaging equipment should be five years old or less.
- No more than 30 per cent of imaging equipment should be between six and 10 years old.
- No more than 10 per cent of imaging equipment should be older than 10 years.

The age compositions of current CT and MRI machines are identified using CADTH inventory data to establish a benchmark to forecast equipment age out to 2040. The age of the equipment was collected for 327 MRI machines and 506 CT machines. There is no publicly available microdata on the specific age composition of medical imaging equipment. (For example, there are 167 CT machines aged zero to five years, but no data showing how many of these machines are two or three years old.) For this analysis, we assume that the machines are evenly distributed within the age categories.

As shown in Chart 11 and Table 8, Canada is currently not meeting the golden rules and will, therefore, require additional investments just to bring Canada up to that standard. Therefore, the total number of units required will be equal to the trend increase in supply (as outlined above) plus the number of new machines needed to reduce the average age of current stock of medical imaging equipment and maintain the recommended golden rules profile over the forecast.

Over the forecast period, the number of new machines is calculated based on how much of the current stock needs to be replaced now and then how much of the stock will need to be replaced each year as it ages to ensure that our health system maintains an age structure aligned with the golden rules.

12 European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry, "COCIR."

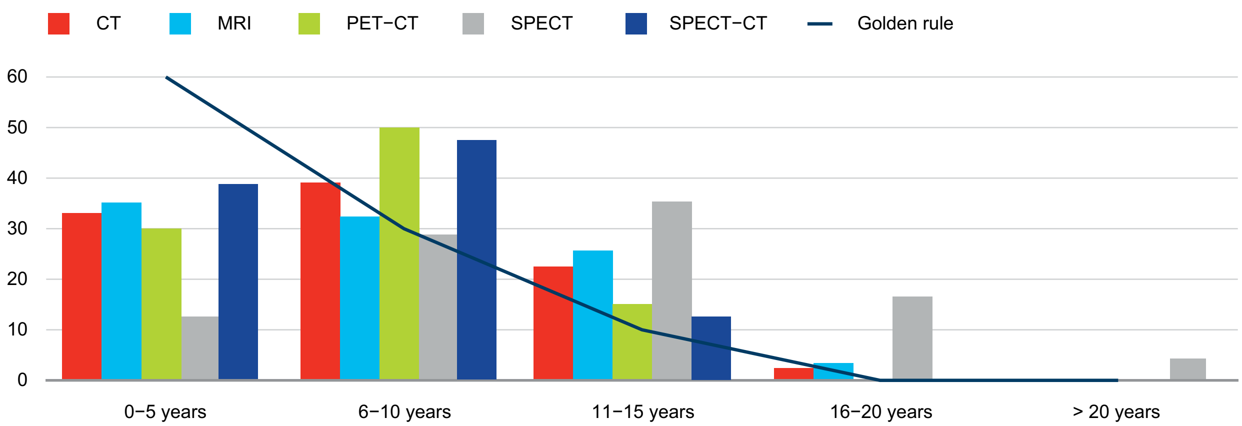
13 Canadian Agency for Drugs and Technologies in Health, *Canadian Medical Imaging Inventory, 2017.*

Canada is not meeting the golden rules and will require additional investments to bring it up to that standard.

Chart 11

Canada's aging medical imaging fleet

(percentage of units)



Sources: The Conference Board of Canada; CADTH, Canadian *medical imaging inventory* 2017.

Table 8

Stock of CT and MRI medical imaging units

	Golden rule	Actual	Current stock	To achieve golden rule
0–5 years	60%	34%	282	500
6–10 years	30%	36%	304	250
≥ 11 years	10%	27%	221	83

Sources: The Conference Board of Canada; CADTH, *The Canadian medical imaging inventory, 2017.*

Results

Currently, the Canadian radiology sector is ill-equipped to meet patient demands. Canadian radiologists are using equipment that is mostly (66 per cent) over five years old. This is concerning because, according to the golden rules, a radiology sector is most effective when its practitioners are primarily using equipment aged five years or less. It is also concerning that 27 per cent of equipment in the radiology sector is 11 years old or more. For patients, this is worrisome because equipment in this age range has not benefited from recent technological advances in imaging diagnostics, creating the potential for inferior diagnostic testing.

Demand for medical imaging

Between 2017 and 2040, the number of CT examinations in Canada is expected to more than double, going from 5.6 million to 11.9 million. (See Table 9.)[14] The rate at which demand for MRI exams is forecast to grow is even greater—from 1.9 million in 2017 to 5.3 million by 2040. Even after assuming a steady increase in the number of exams performed by each machine per year, the number of machines required to satisfy demand increases significantly over the forecast period. The number of CT machines required is 1,056 in 2040 and the number of MRI machines required is 826.

Supply of medical imaging equipment

We assumed that net additions to imaging machine supply will stay constant at current levels. This implies that a net of 13 CT and 13 MRI new machines are added to the Canadian medical imaging stock per year starting in 2017.

The number of CT machines is forecast to increase by 53 per cent between 2017 and 2040, and the number of MRI machines will rise by 82 per cent. By 2040, there will be 860 CT units and 655 MRI units in operation across Canada. (See Table 10.)

Table 9

Forecast of demand for medical imaging examinations

	2017	2020	2025	2030	2035	2040
Population (millions)	36.64	37.70	39.43	41.04	42.44	43.63
Number of CT examinations (millions)	5.61	6.62	7.88	9.20	10.54	11.90
Number of MRI examinations (millions)	1.86	2.66	3.28	3.94	4.61	5.29
Number of CT machines	561	672	773	872	966	1,056
Number of MRI machines	366	450	543	639	733	826

Source: The Conference Board of Canada.

Table 10

Forecast of supply of medical imaging equipment

	2017	2020	2025	2030	2035	2040
Total number of units in service: CT	561	600	665	730	795	860
Total number of units in service: MRI	366	405	470	535	600	665

Source: The Conference Board of Canada.

Age of medical imaging equipment based on golden rules

While our forecast suggests that the supply of CT and MRI units will each increase by 299 units between 2017 and 2040, that is not the total number of new machines that will need to be purchased. Some of the supply will always need to be retired and replaced to bring the current stock up to the golden rules standard and then to maintain that standard over the forecast period.

14 Full results by year are available in Appendix A.

To bring the current stock of imaging equipment in line with the golden rules, 151 new CT and 91 new MRI machines are needed. Over the forecast, a total of 594 MRI and 880 CT machines will need to be purchased to maintain the age composition of the stock at the golden rules level.

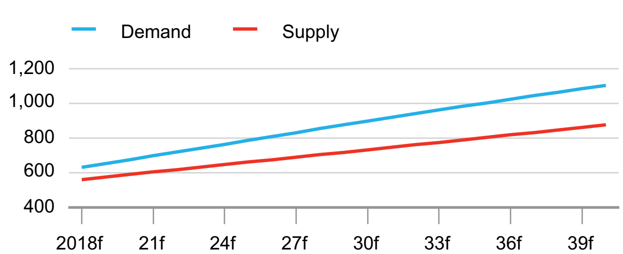
Estimated balance between future demand and supply of medical imaging equipment

Growth in supply is forecast to be weaker than growth in demand for medical imaging diagnostics. If current investment trends continue, the supply of medical imaging equipment will not be enough to accommodate demand over the next 20 years, with the gap between supply and demand growing over the forecast. (See charts 12 and 13.)

Chart 12

CT machines supply and demand

(units)

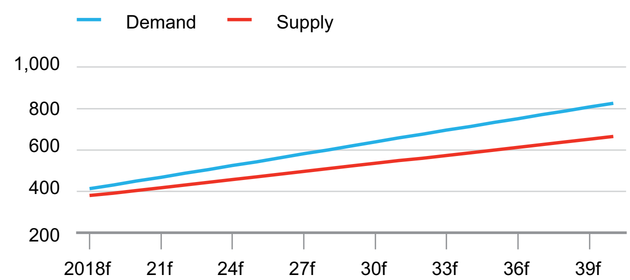


Source: The Conference Board of Canada.

Chart 13

MRI machines supply and demand

(units)



Source: The Conference Board of Canada.

For patients, the future availability levels for medical imaging equipment is concerning. Patients seeking radiological services will face supply shortages for both CT and MRI diagnostics, placing an unnecessary burden on the Canadian health care system. In 2040, we estimate that demand for services will exceed supply by 13 percentage points for CT scans and 24 points for MRI services.

Investments required in imaging equipment

On average, a new CT machine costs $1 million, while the cost of an MRI machine is $3.5 million. These costs are used to determine the level of investment required to achieve the golden rule for equipment age. With new machines constantly required to replace aging stock, investments will be required through 2040. (See Table 11.) The cost to bring the current stock up to the golden rules' minimum levels would be $469 million (in 2017 dollars). Over the forecast, an additional $2.9 billion will need to be spent to keep the projected supply aligned with the golden rules.

Even with these investments, demand will continue to outstrip supply. In order to close the gap, the 13 new CT and MRI machines projected to be purchased each year will not be enough. Further, those additions to the stock will also require more replacement purchases in order to keep the total stock at the golden rule levels. In total, an additional 278 CT units and 211 MRI units will need to be purchased over the forecast period, at a total cost of $1 billion in order to meet demand and keep the stock of equipment at the golden rule minimum. (See Table 12.)

Overall, a total of $4.4 billion ($3.4 billion to modernize and maintain the fleet and another $1 billion to meet the increase in demand and keep those machines modern) will be required through 2040.

Table 11

Stock of CT and MRI medical imaging units

	2017	2017–20	2020–25	2025–30	2030–35	2035–40	Cumulative
Number of new units: CT	151	97	162	186	207	228	1,031
Cost of new units: CT (2017 $ billions)	151	97	162	186	207	228	1.03
Number of new units: MRI	91	62	99	123	144	165	685
Cost of new units: MRI (2017 $ billions)	318	217	348	432	504	577	2.40

Source: The Conference Board of Canada.

Table 12

Additional units required to close the demand gap

	2017–20	2020–25	2025–30	2030–35	2035–40	Cumulative
Number of units: CT	**65**	**26**	**56**	**62**	**69**	**278**
Cost of CTs (2017 $ millions)	**65**	**26**	**56**	**62**	**69**	**278**
Number of units: MRI	**40**	**20**	**42**	**50**	**58**	**211**
Cost of MRIs (2017 $ millions)	**141**	**70**	**148**	**175**	**205**	**738**

Source: The Conference Board of Canada.

The impact of increased funding: A little more goes a long way

What would happen if we were to increase funding on new medical imaging machines over the next five years? In four different spending scenarios over a five-year time horizon, we quantified how increasing funding would affect the number of machines in operation, wait times, and the economy. (See Table 13.) We concluded that the impact of each additional dollar of investment can be substantial.

The analysis in this section depends on a few critical assumptions:

- a projection of the number of MRI and CT machines in operation, including how many will need to be replaced every year;
- the volume of diagnostic imaging that can be performed per machine;
- the number of people entering wait lists.

In each scenario, we assumed older machines were retired in line with our recommendations in Chapter 4. The volume of diagnostic images per machine was increased in line with recent trends, and the number of people entering wait lists increased in line with trends of exams per population.

Currently, Canada adds 13 new CT and MRI machines to the stock every year. In our base-case scenario, we grew the stock of machines in line with these recent trends. However, many of the current stock of CT and MRI machines are old and, as detailed in Chapter 4, should be replaced. Consequently, a large portion of the total new machines purchased (nearly 80 per cent in our baseline forecast) is devoted to replacing old, obsolete machines. That investment, therefore, has little impact on wait times. If the machines are able to remain in service for longer than expected, some of this funding could be directed to growing the fleet.

Table 13
Investment scenarios

	Total capital spending, 2018–22	Cost of replacing aging machines, 2018–22	Funding to grow the fleet, 2018–22	How many machines do we add to the fleet each year?
Base case	$1.4 billion	$1.1 billion	$293 million	13 CT + 13 MRI
Scenario A	$1.2 billion	$1.1 billion	$158 million	7 CT + 7 MRI
Scenario B	$1.5 billion	$1.1 billion	$450 million	20 CT + 20 MRI
Scenario C	$1.7 billion	$1.1 billion	$585 million	26 CT + 26 MRI

Source: The Conference Board of Canada.

Investment spending ranges from $1.2 billion to $1.7 billion across the four scenarios. In all cases, $1.1 billion is required to replace aging machines, as we estimate 68 CT machines and 42 MRI machines need to be replaced on average each year over the next five years. The base-case scenario is in line with recent trends in the growth of the stock of machines but retires older machines as recommended in Chapter 4. This scenario is identical to the forecast we presented in Chapter 4. Scenario A looks at the impact of slowing the net increase in new machines, while scenarios B and C look at substantial increases in the growth of the stock of machines.

Our analysis shows that a small increase in capital funding can have a dramatic effect on the size and age of the total fleet of medical imaging machines, and therefore, a dramatic impact on wait times. Table 14 shows the results of our analysis on wait times and economic indicators. In the base case, we see a slight decline in average wait times compared with wait times in 2017 (18 days for CT scans, 64 days for MRI scans). In the pessimistic Scenario A, spending $135 million on additional machinery leads to a surge in wait times. Wait times for MRIs more than double, while for CT scans they more than quadruple. On the other hand, in both Scenario B and Scenario C, a few hundred million dollars in extra investment means wait times are eliminated[15] by 2022.

There are some important caveats in this analysis. We make all the same methodological assumptions discussed in Chapter 4, particularly around the depreciation of medical imaging machines and the golden rule. We also make two additional key assumptions: demand does not fluctuate from the base case even as wait times fall, and machine allocation is perfectly efficient. These assumptions are necessary simplifications to make the modelling possible. In practice, falling wait times are likely to lead to a surge in new demand for scans. Additionally, satisfying local demand is a complicated allocation problem, and we only model a nationwide wait list. Fully eliminating wait times everywhere would require machines across the country, even in the most remote communities, so that no one ever had to wait for a scan. These machines would then spend most of their time sitting idle.

The dollar costs reported above represent capital costs only. Adding new machines to the medical imaging fleet also means incurring ongoing operating costs not accounted for above. These costs would be substantial and would continue beyond the five-year horizon we model here. The true cost of a larger medical imaging fleet is therefore larger than just the capital cost figures above.

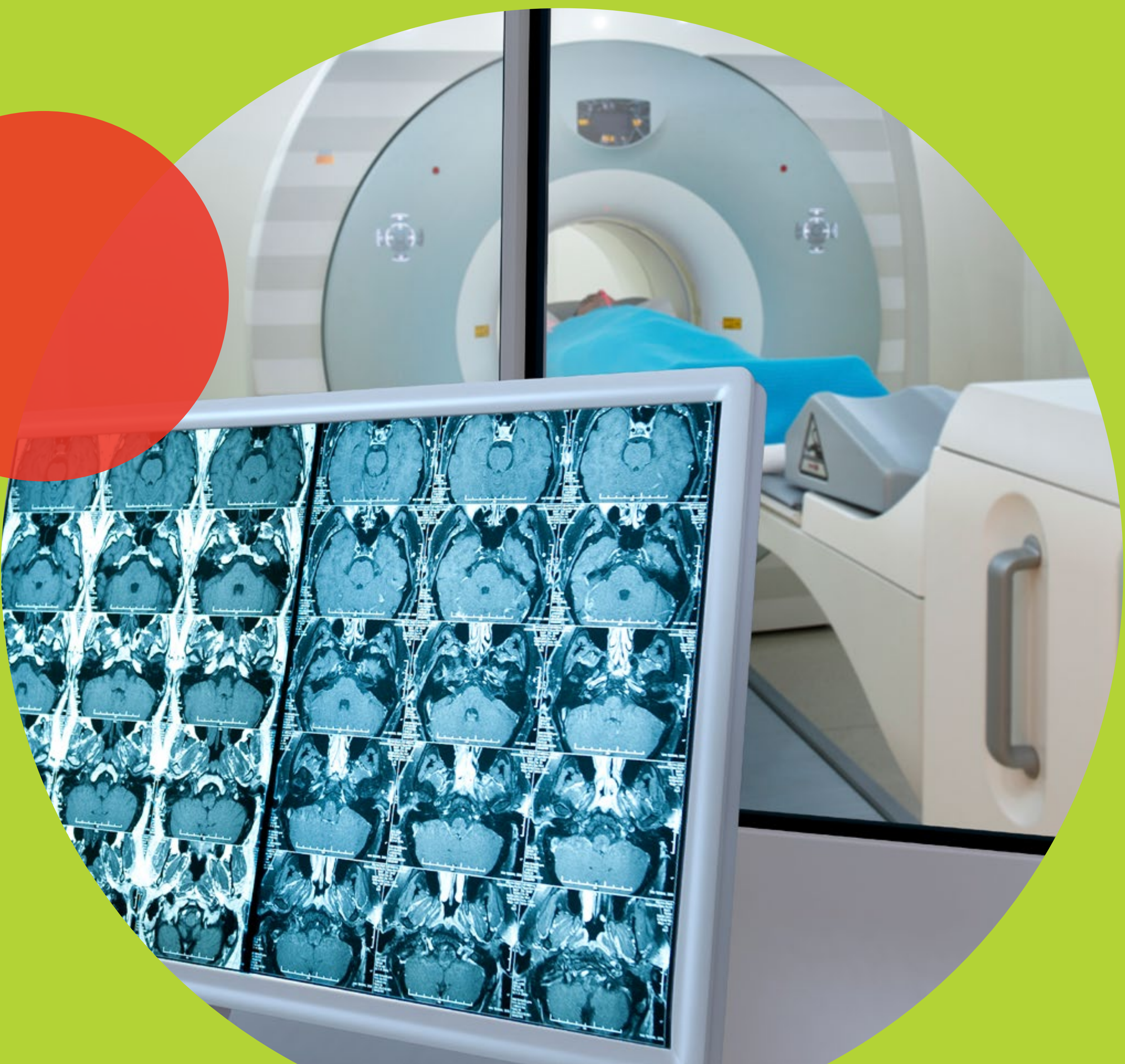
Table 14
Scenario results

	2022 average wait times	Lost wages (2022)	Lost GDP (direct + indirect, 2022)	Lost tax revenues (2022)
Base case	CT: 16 days MRI: 56 days	$1.9 billion	$2.9 billion	$446 million
Scenario A	CT: 67 days MRI: 133 days	$4.3 billion	$6.6 billion	$1.0 billion
Scenarios B & C	CT: 0 days MRI: 0 days	$0	$0	$0

Note: Wait times cannot go to zero in practice; see Caveats section.
Source: The Conference Board of Canada.

15 Wait times cannot go to zero in practice; see Caveats section.

Chapter 5
Conclusion and next steps



Our analysis produced two major findings. First, excessive wait times for CT and MRI diagnostics result in billions of dollars of lost economic output per year. Second, major investments in CT and MRI equipment will be required to modernize the supply over the long term.

These results are concerning for radiologists and patients in particular and for the aging Canadian population in general. Radiologists are using mostly out-of-date equipment to treat and diagnose patients while at the same time struggling to cope with large increases in demand for services. Patients will continue to face longer-than-recommended wait times across Canada and risk being forced out of the workforce temporarily while waiting for their diagnoses. All Canadians are indirectly affected by these wait times, as the resulting reduction in GDP output leads to lower government revenues—a situation that hurts the ability of governments to provide social and other services for Canadians.

The costs to the Canadian economy of an inadequate supply of medical imaging equipment are distributed unevenly across Canada. Per-patient costs in Western Canada are higher, largely because weekly earnings there are higher than in Central and Atlantic Canada. There are also differences among the provinces in the maximum recommended wait time for both CT and MRI diagnostics, which can impact patient outcomes.

Due to data limitations, our analysis does not estimate the lower productivity in our health care system resulting from long wait times, nor does it estimate the additional costs incurred by caregivers. If these factors were incorporated into this analysis, the national wait-time costs would be even higher. A more thorough analysis that provided greater insights into the economic costs of long wait times and a lack of medical imaging equipment would be possible if all provinces had more detailed information on patient wait times. Improved data collection would greatly help to inform health policy in Canada, allowing governments to better address the challenges of excessive wait times and the distribution of medical imaging equipment.

In response to these long wait times that will only continue to grow through 2040, Canada should prioritize investment in medical imaging equipment. Currently, much of Canada's stock of medical imaging equipment is out of date and does not meet international standards for health service excellence. This suggests that delaying the much-needed investment in this equipment will only make the current situation worse over the forecast period, given that demand for the services will continue to surge due to the aging of the population.

Appendix A

Forecast of medical imaging equipment (CT and MRI) and Canadian population

Table 1

Pan-Canadian MRI and CT wait-time benchmarks

	Population forecast	CT examinations	MRI examinations	CT units	MRI units
2019	37,350,000	6,380,367	2,542,704	652	431
2020	37,700,970	6,623,247	2,661,942	672	450
2021	38,051,010	6,869,364	2,782,886	692	468
2022	38,399,840	7,118,654	2,905,510	713	487
2023	38,747,210	7,371,051	3,029,783	733	506
2024	39,092,320	7,626,378	3,155,632	753	524
2025	39,432,450	7,884,058	3,282,811	773	543
2026	39,766,940	8,143,886	3,411,227	793	562
2027	40,095,630	8,405,742	3,540,822	813	581
2028	40,417,400	8,669,302	3,671,451	832	601
2029	40,731,630	8,934,331	3,803,004	852	620
2030	41,037,790	9,200,601	3,935,372	872	639
2031	41,334,980	9,467,787	4,068,406	891	658
2032	41,623,150	9,735,749	4,202,033	910	677
2033	41,902,040	10,004,290	4,336,157	929	695
2034	42,173,110	10,273,631	4,470,861	948	714
2035	42,436,550	10,543,709	4,606,110	966	733
2036	42,691,880	10,814,288	4,741,790	985	752
2037	42,938,750	11,085,160	4,877,799	1,003	770
2038	43,176,740	11,356,095	5,014,028	1,021	789
2039	43,407,900	11,627,506	5,150,648	1,039	807
2040	43,632,210	11,899,295	5,287,609	1,056	826

Source: Canadian Association of Radiologists.

Appendix B

Data set, data limitations, and study population

Maximum recommended wait times were collected from the Canadian Institute for Health Information (CIHI), the Wait Time Alliance (WTA), and the provincial health regulators. Median patient wait times were obtained from the provincial health regulators through their online wait-time databases. Because there are no established benchmarks for CT and MRI diagnostics, this information was not available through CIHI. Data relating to the distribution of patients waiting, by percentile, were available only for Alberta, Nova Scotia, and Saskatchewan. We used the Alberta data set to estimate patient distributions for the other provinces because of its greater analytical depth and inclusion of some descriptive statistics, compared with Saskatchewan and Nova Scotia. The maximum recommended days for treatment (see Table 1), median wait time for treatment (see Table 2), and excess patient wait time (see Table 3) are shown below.

Table 1

Maximum recommended wait time for treatment

(days)

CT	30	600
MRI	30	405

Note: Days are standardized across priority levels and are measured by the date of requisition to the date of procedure and/or diagnostic exam delivery.
Sources: CIHI; WTA; provincial health regulators.

Table 2

Median wait time for treatment

(days)

	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	N.L.
CT	42	28	17	35	6	28	56	30	44	7
MRI	41	70	28	112	35	70	28	50	80	91

Sources: Provincial health regulators.

Table 3

Excess patient wait time

(days)

	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	N.L.
CT	12	-2	-13	5	-24	-2	26	0	14	-23
MRI	11	40	-2	82	5	40	-2	20	50	61

Note: Data = Table 2 – Table 1.
Sources: CIHI; WTA; provincial health regulators.

Table 4

Proportion of patients with wait times exceeding the maximum recommended time

	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	N.L.
CT	45%	40%	25%	45%	35%	40%	50%	45%	45%	35%
MRI	45%	64%	45%	70%	45%	64%	45%	70%	70%	70%

Note: Based on the Alberta benchmark.
Sources: Provincial health regulators.

The values highlighted in red in Table 3 indicate that patients at the median are waiting longer than the recommended maximum time of 30 days. Negative values indicate that patients at the median are waiting an appropriate number of days. For provinces for which there are no median wait time data, monthly wait time averages were used to calculate a yearly median value. These values are derived using a 30-day maximum wait time (see Appendix A, Table 1), which impacts the remaining estimates used to calculate patient costs. The proportion of patients with wait times exceeding the maximum recommended time (see Table 4) is estimated using the median wait time data and Alberta wait time distribution data.

The number of radiological exams was obtained from the Canadian Agency for Drugs and Technologies in Health (CADTH) and cross-checked against provincial regulator data for accuracy. These data sources were used because some provincial data sets were not recorded in the CIHI Wait Time Database. Table 5 indicates the number of radiological exams per 100,000 persons. The average number of days waited above the maximum recommended time was calculated using the Alberta data set as a benchmark. (See Table 6.) No other provincial regulator provides detailed patient distribution data by percentile, rendering the Alberta data set the most useful in determining the average number of days above the recommended maximum time for patients.

Table 5

Number of CT and MRI exams per 100,000 population

	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	N.L.
CT	14,520	9,440	11,060	13,970	17,200	16,140	18,780	16,720	10,560	17,120
MRI	3,630	4,480	3,830	5,830	6,130	4,450	5,890	4,980	2,860	3,970

Note: Population-adjusted incidence rate measured by the total number of procedures completed per machine.
Sources: CADTH; provincial health regulators.

Table 6

Average wait times exceeding the maximum recommended period

(days)

	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	N.L.
CT	50	50	50	50	50	50	50	50	50	50
MRI	69	69	69	82	69	69	69	69	69	69

Note: Based on the Alberta benchmark.
Sources: Provincial health regulators.

Since Alberta is the only province with comprehensive patient distribution data by percentile, its data set was used as the basis for the assumptions made about wait times in the other provinces. While Manitoba also collects data on patient distributions for CT and MRI patients, the Alberta data set is preferred because it separates patient wait times by quantile, which facilitates the calculation of both the proportion of patients waiting longer than recommended and the number of days waited per quantile. Other provinces, such as Ontario, provide somewhat similar data by quantile, but not to the extent that we find in the Alberta Wait Time data set. The number of days waited in excess of the recommended maximum wait time are displayed in Table 6.

The most relevant estimate regarding the proportion of patients who must forgo economic activities was derived from Statistics Canada data that were published in 2005.[1] This estimate predicts that between 10 and 14 per cent of patients seeking medical diagnostics must discontinue their economic activities while waiting for treatment, with the 12 per cent estimate having a 95 per cent confidence interval. We use the 12 per cent estimate, paired with the proportion of patients waiting above the maximum recommended time, to collect data on the total number of patients waiting above the maximum recommended time. Lastly, the queue is multiplied by the number of days waited above the maximum time to identify the total number of weeks waited by patients whose incomes are negatively affected while waiting for treatment (See Table 7.)

1 Statistics Canada, Access to Health Care Services.

Table 7

Patients waiting longer than recommended whose economic activities are disrupted

(number of patients)

	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	N.L.
CT	37,770	19,324	6,951	10,094	102,532	64,705	8,559	8,612	866	3,802
MRI	9,442	14,643	2,407	6,552	46,982	28,485	2,416	3,990	365	1,763

Note: Population-adjusted incidence rate measured by the total number of procedures completed per machine.
Sources: CADTH; provincial health regulators.

Unfortunately, we were unable to break out the impact of wait times due to a lack of data. Age cohorts were not identified, and this omission precluded an analysis of the results for each age group in Canada. Data classified by referral or drop-in were also omitted because of data limitations. Some provinces do report details about referrals and drop-ins; however, reliable data could not be identified across the provincial health regulators.

Moreover, the data used in this report do not break wait time into different priority levels. While there are clear guidelines listed by agencies such as the Canadian Association of Radiologists[2] on different wait-time maximums based on priority, producing results for each priority level would be difficult. Some provinces aggregate priorities three and four together, while others report only on priority four data. Because of this variation, this report uses the aggregated data provided by each provincial health regulator, which typically excludes priority one and priority two patient wait times.

This report does not estimate the potential caregiver and health system costs associated with CT and MRI diagnostics in Canada. Instead, it follows the precedent set by The Centre for Spatial Economics in its 2008 report *The Economic Cost of Wait Times in Canada*. Data availability was also a limiting factor. Currently, CIHI and most provincial health regulators collect little data with respect to wait times by quantile or specific information regarding the number of days for patients by quantile. The Alberta data set was therefore used as a national benchmark because it includes detailed information on the patient wait-time distribution over time.

The proportion of patients financially affected was assumed at 12.5 per cent, based on Statistics Canada's reporting from 2005. Since the cost calculations are based on this estimate, a more recent figure would have been used if available. This value is conservative when held against similar assumptions and might therefore underestimate the total number of patients in Canada who are financially affected. Moreover, this report was originally designed to estimate the wait-time costs associated with several specific radiological procedures, including mammography, PET-CT, and SPECT. This was unachievable, however, due to data unreliability and unavailability. For example, there are no standardized collection, publishing, and/or language requirements with respect to reporting wait-time data for most

2 Canadian Association of Radiologists, National Maximum Wait Time Access Targets.

radiological procedures in Canada. Currently, there are no national data collection and analysis benchmarks for CT or MRI wait times.[3]

There are other indirect costs that were not estimated by this report. The relationship between wait times for radiological procedures and the likelihood of increased use of pain medication, for example, was not collected due to a lack of data availability. Similarly, increases in per-patient pharmaceutical costs while waiting for medical imaging diagnostics were not calculated, again because of data unavailability. Another potential cost relating to excessive wait times for radiological services is costs associated with mental health. Again, there are no reliable estimates on the per-patient cost increases in mental health–associated purchases because of wait times for radiological care. These brief examples demonstrate that it would be unrealistic to try to capture every indirect cost associated with wait times when reliable and accurate data are unavailable.

Age was not accurately measured or incorporated in this report. There is evidence to suggest that medical imaging diagnostics skew downward and upward depending on age. This is important because different age groups have different employment rates, productivity levels, and societal contributions. Older demographic cohorts, for example, incur lower losses due to lower workforce labour participation rates than do younger cohorts. Age was not measured by this report because of data unavailability. While some provinces do indicate some age differentiation in their data, there is no standardized approach to collecting age-specific data across Canada.

These limitations strongly relate to issues with data coding and transcription. There are different data coding practices across Canada with respect to recording total wait times for radiological exams. In turn, this means that data can be interpreted differently across the country. This report assumed a standardized interpretation of the data which, of course, might not fully represent each provincial scenario. For example, some patients might expect to wait five days for diagnosis but end up waiting seven days in total. This might be recorded as two days (the total wait time incurred by the patient that was unexpected) in some provinces, while other provinces might record the total wait time as seven days. Because of issues with coding, this report might underestimate total wait times in some provinces.

3 Canadian Institute for Health Information, "Wait Time Meta Data."

Appendix C

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