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CADTH OPTIMAL USE REPORT

The Canadian Medical Imaging Inventory, 2017

Service Line: CADTH Service
Version: 1.0
Publication Date: March 2018
Report Length: 104 Pages

CADTH

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Cite As: The Canadian Medical Imaging Inventory, 2017. Ottawa: CADTH; 2018 Mar.

About CADTH: CADTH is an independent, not-for-profit organization responsible for providing Canada's health care decision-makers with objective evidence to help make informed decisions about the optimal use of drugs, medical devices, diagnostics, and procedures in our health care system.

Funding: CADTH receives funding from Canada's federal, provincial, and territorial governments, with the exception of Quebec.

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Acknowledgements

Other contributors we would like to acknowledge: Ann Vosilla, Kathleen Kulyk, Lisa Farrell, Lisa Pyke, Sheila Tucker, and Stephanie Smith for their efforts in facilitating engagement with survey participants; Melissa Severn for literature search, reference retrieval, and reference database management; Carolyn Brown for copy-editing, Kinneret Globerman for revisions, Pierre LeBel for translating the text of the report and numerous other communications into French; Kasia Kaluzny for providing knowledge translation and implementation support on the project; Teo Quay and Lesley Dunfield for reviewing the report; and Pierre Martinelli for project management.

Executive Summary

In 2015, CADTH assumed the task of conducting a biennial survey of medical imaging providers in Canada, following the Canadian Institute for Health Information's (CIHI's) data collection until 2012. This report summarizes the results of the second iteration of the CADTH Canadian Medical Imaging Inventory.

Methods

We collected information on six modalities using a Web-based survey, supplemented with information from suppliers of diagnostic imaging equipment, data validators, report reviewers, and literature searches. The modalities were:

- computed tomography (CT)
- magnetic resonance imaging (MRI)
- single-photon emission computed tomography (SPECT)
- positron emission tomography–computed tomography (PET-CT)
- positron emission tomography–magnetic resonance imaging (PET-MRI)
- single-photon emission computed tomography–computed tomography (SPECT-CT).

The survey was launched on April 18, 2017, and data collection formally closed on June 9, 2017. Previous data were entered into a database with a Web interface and respondents were invited to amend the data associated with their sites — or, if there was no pre-existing entry, to complete the survey. High-level data were reviewed by pre-identified regional and provincial validators, who supplied corrections and supplementary data, which were entered into the database. Identified stakeholders and survey respondents were given the opportunity to review the report during the stakeholder feedback process.

Results

A submitted survey was received from 147 sites, and an additional 223 surveys were accessed and modified but not submitted as final. At least minimal data (modalities and unit counts) were available for a total of 505 sites. The majority of sites were publicly funded facilities. Sixty-nine per cent were urban, 29% were rural, and 2% were remote.

Computed Tomography

- We identified a total of 561 CT units in Canada, up from 419 units in 2007. All provinces or territories had at least one unit. Ontario and Quebec had the most units, followed by British Columbia and Alberta. The three northern territories had one unit each.
- From examination data reported by validators, we estimated that a total of 5.61 million CT examinations were performed in the most recent fiscal year in Canada, up from 3.38 million in 2007. This is equivalent to 153.0 exams per 1,000 people, up from 103.3 in 2007.
- CT units operate for an average of 76.5 hours per week and 12.1 hours per day. Most operate on weekends. CT is used across disciplines, with approximately a quarter of the time used in the fields of oncology, followed by neurology, respiratory, and hepatobiliary.
- When the number of CT units per population for Canada is compared with other countries that report CT units to the Organisation for Economic Co-operation and Development (OECD), Canada appears in the lower half of the reported numbers. For the number of exams per population, Canada appears around the midpoint.

- Half the units reported on in the survey had 64 cross sectional images or slices, with about an eighth having 128 slices. Three-quarters incorporate image reconstruction techniques for dose reduction, 81% are equipped with dose management controls, and 92% record dose by exams.
- One-third of CT units were five-years-old or less, 40% were six- to ten-years-old, and 23% were 11- to 15-years-old. None were older than 20 years.

Magnetic Resonance Imaging

- We identified a total of 366 MRI units in Canada, up from 222 units in 2007. All provinces and one territory had at least one unit. Ontario and Quebec had the most units, followed by British Columbia and Alberta. Yukon has a single unit.
- From examination data reported by validators , we estimated that a total of 1.86 million MRI examinations were performed in the most recent fiscal year in Canada, up from around 1 million in 2007. This is equivalent to 51.0 exams per 1,000 people, up from 31.2 in 2007.
- MRI units operated for an average of 78.7 hours per week and 13.1 hours per day. Most also operated on weekends. MRI is used across disciplines, with approximately a quarter of the time used for musculoskeletal exams, followed by neurological, oncological, and hepatobiliary exams.
- When the number of MRI units per population for Canada is compared with other countries that report MRI units to the OECD, Canada appears in the lower half of the reported numbers. For the number of exams per population, Canada appears around the midpoint. This is consistent with the positions for 2015.
- The majority (83%) of MRIs have field strengths of 1.5 Tesla.
- Thirty-six per cent of MRI units were five-years-old or less, 33% were six- to ten-years-old, and 26% were aged 11- to 15-year-old. None were older than 20 years.

Positron Emission Tomography–Computed Tomography or Positron Emission Tomography

- We identified a total of 51 PET-CT units in Canada, up from 21 units in 2007. All were PET-CT, indicating that PET had been replaced as a modality. Nine provinces had at least one unit, up from eight in 2007, with Ontario and Quebec having the most. Newfoundland and Labrador installed a unit between 2015 and 2017.
- From examination data reported by validators, we estimated that a total of 90,530 PET-CT examinations were performed in the most recent fiscal year in Canada. Exam data for 2007 was not available.
- PET-CT units operate for an average of 40.4 hours per week and 8.6 hours per day. PET-CT is primarily used for oncology (80%), followed by cardiac and neurological use.
- Two-thirds of units have sixteen slices. The majority of units (90%) were equipped with dose management controls and 77% recorded patient radiation dose by exam.
- Thirty-two per cent of PET-CT units are five-years-old or less, 53% are six- to ten-years-old, and 16% are between 11- and 15-years-old.
- A quarter of sites had access to a cyclotron for generating radioisotopes. Two-thirds of the sites without access to a cyclotron obtained radioisotopes from commercial sources.

Positron Emission Tomography–Magnetic Resonance Imaging

- The hybrid modality of PET-MRI is the newest specialist imaging modality. We identified three units currently operating for clinical research purposes in Ontario.
- As the PET-MRI has yet to enter clinical use, we do not have any examination or use data.

Single-Photon Emission Computed Tomography

- We identified a total of 330 SPECT units in Canada, down from 603 units in 2007, although this figure is approximate because Ontario reported a combined figure for SPECT and SPECT-CT. Nine provinces had at least one unit. Ontario and Quebec had the most units, followed by Alberta and British Columbia.
- Individual data for SPECT exams were not available for all provinces, so the combined exams are reported under SPECT-CT. Exam data for 2007 was not available.
- SPECT units operate for an average of 43.5 hours per week and nine hours per day. A minority operate on weekends. SPECT is primarily used for cardiac examinations (40%), followed by oncology and musculoskeletal exams.
- Three-quarters of units have two detector heads, and one-quarter are dedicated cardiac units.
- Overall, Canada has some of the oldest SPECT units. Thirteen per cent of these units are less than five-years-old, 29% are between six- and 10-years-old, 36% are 11- to 15-years-old, and 21% are more than 15-years-old.

Single-Photon Emission Computed Tomography–Computed Tomography

- We identified a total of 261 SPECT-CT units in Canada, up from five units in 2007, although the number is approximate because Ontario reported a combined figure for SPECT and SPECT-CT. All 10 provinces had at least one unit. Ontario and Quebec had the most units, followed by British Columbia and Alberta.
- From data reported by validators, with a small number of imputed exams, a total of 1.35 million SPECT or SPECT-CT exams were carried out in Canada.
- SPECT-CT units operate for an average of 45.2 hours per week and nine hours per day. A minority operate on weekends. SPECT-CT is primarily used for cardiac examinations (36%), followed by oncology and musculoskeletal exams.
- Almost all units have two detector heads. One-third have four slices, and 20% have one and 16 slices.
- Two-thirds were equipped with dose management controls and 61% recorded patient radiation dose by exam. More than half incorporated image reconstruction techniques for dose reduction.
- Forty per cent of SPECT-CTs are less than five-years-old, half (48%) are between six- and 10-years-old, and 12% are 11- to 15-years-old.

Picture Archiving and Communications System

- One-third (28%) of sites had access to a local or institutional picture archiving communications system (PACS) network, 39% had access to a regional network, and one-third (33%) had access to a provincial network.
- Almost all sites allowed access to PACS images outside the imaging department, and two-thirdsallowed access to other sites within the provincial health care system.
- Almost all sites with CT, MRI, SPECT, PET-CT, or SPECT-CT stored and accessed images for these modalities on PACS. A minority of sites without each of these modalities could also access images. We do not have information about PET-MRI.

Limitations

- For feasibility, this iteration of the survey was restricted to six specialist imaging modalities and does not include others that are more common and widespread (e.g., X-ray and ultrasound).
- As we do not have a definitive list of facilities containing the equipment, and, as the survey was voluntary, we cannot ensure that all facilities or departments containing the modalities were contacted or responded.
- A limited amount of imputation was used to carry forward data from previous years. Data for hours and types of use was available for only a limited number of sites.

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Abbreviations

CADTH	Canadian Agency for Drugs and Technologies in Health
CIHI	Canadian Institute for Health Information
CMII	Canadian Medical Imaging Inventory
CT	computed tomography
MRI	magnetic resonance imaging
OECD	Organisation for Economic Co-operation and Development
PACS	picture archiving and communication system
PET	positron emission tomography
PET-CT	positron emission tomography–computed tomography
PET-MRI	positron emission tomography–magnetic resonance imaging
SPECT	single-photon emission computed tomography
SPECT-CT	single-photon emission computed tomography- computed tomography

Introduction

In Canada, medical imaging is a vital service within our health care system, providing the basis for diagnosis, staging, and monitoring in a variety of diseases and conditions. Computed tomography (CT), magnetic resonance imaging (MRI), and nuclear medical imaging, including single-photon emission computed tomography (SPECT) and positron emission tomography (PET), have become commonplace in medical imaging and nuclear medicine departments across Canada. In recent years, hybrid technologies such as single-photon emission computed tomography– computed tomography (SPECT-CT), positron emission tomography–computed tomography (PET-CT), and positron emission tomography–magnetic resonance imaging (PET-MRI) have further expanded the imaging repertoire. Other recent innovations include techniques that provide higher quality imaging, lower radiation doses, and faster examinations.[1,2]

As imaging modalities advance, decision-makers and clinicians face complex choices about which medical imaging technologies to acquire and use. Each modality offers unique characteristics, advantages, and disadvantages. However, decisions about adoption and implementation are made within the context of a finite health care budget and limited availability of clinical and technical expertise. In addition, the need for appropriate use of imaging studies has been highlighted by Choosing Wisely Canada[3,4] and Canada Safe Imaging.[5] From the patient's perspective, overuse is associated with unnecessary exposure to radiation, inconvenience due to travel and appointments, increased wait times for necessary procedures, and risks of further investigation and treatment arising from false-positive or incidental findings.[6] From the health care system's perspective, overuse is associated with increased wait times for necessary procedures, and increased costs.[7]

Given these considerations, current information regarding the status of medical imaging equipment in Canada is critical. In 2001, CADTH (then the Canadian Coordinating Office for Health Technology Assessment) conducted its first inventory of diagnostic imaging equipment in Canada. From 2003 to 2012, the Canadian Institute for Health Information (CIHI) continued to collect data on the inventory and use of diagnostic imaging equipment.[8-10] In 2015, CADTH resumed work on the inventory to meet the ongoing need, producing its first report in 2016.[11] This updated report summarizes the findings of the 2017 iteration of the inventory.

For this iteration, data were collected on six modalities: CT, MRI, SPECT, PET-CT (which has almost entirely superseded PET), PET-MRI, and SPECT-CT. (Appendix A describes the modalities and their use.) These six were given priority over several modalities captured in previous iterations of the survey (angiography units, cardiac catheterization units, bone densitometers, and lithotripsy imaging),[8-10] and over the widely used modalities of X-ray and ultrasound imaging. We limited the scope to ensure feasibility and were guided by stakeholder prioritization of these six modalities; however, the scope will be re-assessed and expanded in future iterations if feasible. Data were also captured on infrastructure requirements of current concern: use of and access to a picture archiving and communication system (PACS) for each of the six modalities, and the source of isotopes for PET and its hybrid modalities.

Objectives

The purpose of this pan-Canadian inventory is to document current practices and developments related to the supply, distribution, technical operation, and general clinical use of selected medical imaging modalities at public and private Canadian health care facilities. The specific overall objectives of the project are:

1. to determine the number of units (medical imaging devices) of selected medical imaging modalities in Canada
2. to provide accurate and timely data on the supply, distribution, and use of selected medical imaging units in Canada
3. to improve current understanding of the technical characteristics of medical imaging equipment in Canada
4. to report on trends and developments in medical imaging equipment use across Canada
5. to inform medical imaging–related strategic planning on a national, provincial, or territorial basis.

Methods

Identification of Respondents and Data Collection

Data Sources

Data were primarily collected via a Web-based survey on the CADTH website. (The English language survey is shown in Appendix B.) Both English and French versions were offered. The 2017 survey was based on the 2015 iteration of the survey, with the following changes:

- Questions Removed
  - breakdown of use between diagnostic, interventional, and other. 2015 responses to the question indicated almost exclusively diagnostic use.
- Questions Added
  - breakdown of use according to body system for the most relevant body systems for CT, MRI, PET-CT, and SPECT-CT, based on literature searches and expert input
  - whether a site's ordering system included a screen for appropriate ordering.

Survey respondents who had participated in previous iterations of the inventory were presented with pre-populated forms for updating and completion. Respondents for new sites were presented with blank forms. Data for pre-population were obtained from the following sources:

- site-level data from the Canadian Medical Imaging Inventory (CMII) 2015 survey: These data included responses from site survey responses, supplemented by data validators, and a supplementary grey literature search conducted for the 2015 report
- unit-level (technical) data from the CMII 2015 survey, for units installed between 2012 and 2015
- unit-level data from the CIHI 2012 data set, for units installed before 2012 (site-level data were not carried forward)
- unit-level availability data provided by three major suppliers of diagnostic imaging equipment (Toshiba, Siemens, GE Healthcare).

The CMII 2015 final data set was restructured and merged with the new data. Differences in site names, unit technical specifications, and dates of installation were reconciled manually across data sources. Site names and first year of operation of imaging equipment, in particular, were inconsistent across sources. If the data source offered a year of installation, but indicated that the first year of operation was not the first year of operation, then the first year of operation was assumed to be the year after installation.

Site-level data consisted of unit availability and counts by modality, and the following measures by modality: average hours of use per day and per week, 24-hour and weekend use, total number of exams in the last fiscal year across all units (some sites had only the last calendar year available, and reported that), and breakdowns of types of use into categories. Site-level data also included the type of facility, the use of PACS, and the source of isotopes (for PET or hybrid PET modalities). Unit-level information consisted of manufacturer, model, year of installation, and modality-specific technical characteristics, such as the number of detectors/slices and availability of dose-management controls for CT, and the field strength for MRI.

Respondents to the 2017 survey were asked to update the available data to reflect the status at the time of survey response. In particular, survey respondents were asked to identify

units that had been decommissioned, regardless of the year, and to provide the year of decommissioning. If survey responders did not update the survey, we assumed that there had been no changes from the 2015 survey, and we specifically mentioned this assumption when we sent out the survey.

Data from validators for unit counts and examinations in the last fiscal year were preferentially used over survey data to calculate unit counts and counts per population, exams, and exams per population. If data from validators were incomplete, data from the survey were used. For 2017, validated examination data were available for most jurisdictions, and imputation was used only for a minority of jurisdictions for SPECT and SPECT-CT, in comparison with 2015, when all examination counts for all modalities were estimated using imputation. Site-level unit counts supplied by validators were used to identify surplus units in the database (duplicates or decommissioned units that had not been identified as such, based on the assumption that the oldest unit or units were the ones decommissioned).

Identification of Potential Respondents

Most respondents were pre-identified using a database of previous participants. These contacts were updated to account for changes due to position turnover, retirement, and restructuring. Potential respondents included individuals working in private or public health care settings that operate medical imaging equipment. Occupations included executive (e.g., president of a private facility, hospital administrator) and leadership positions (e.g., chief technologist, manager or director of diagnostic imaging, site coordinator). Some respondents were identified through CADTH liaison officers, external stakeholders, and participant referrals.

Passive methods of recruitment included promotion of the renewed survey on the CADTH website and social media, including Twitter and LinkedIn. It is unclear whether any participants were identified through these channels.

To access the survey, all participants were asked to register a profile on the CADTH website to ensure that their response was linked to a unique registration profile. Registrants were matched to sites if there was a pre-existing record, or, if there was no pre-existing record, registrants were presented with a blank form to create a new record.

Duration of Survey

The survey opened on April 18, 2017, and data collection closed on June 9, 2017.

Validation

Upon survey closure on June 9, 2017, we sent summary statistics of the number of units per modality in each jurisdiction to pre-identified validators. Depending upon the jurisdiction, each validator reviewed data for an entire province or for one or more health regions within a province. Validators assessed the summaries for accuracy and provided corrections and information (unit counts or examinations, either at a site or jurisdictional level) on non-responders. Validators were also asked to encourage non-responders in their regions to participate in the survey by the extended deadline (September 11, 2017).

Validators also provided unit counts for their jurisdiction (province or region) and examination data for a subset of jurisdictions.

Identified stakeholders and survey respondents were given the opportunity to review a draft report during a stakeholder feedback process. The report underwent two rounds of internal review and a formal peer-review process before publication.

Data Analysis

Additional data sources are presented in Table 1, and use of the data sets in the analysis in Table 2.

Table 1: Additional Data Sources

Data Source	Application of Data
Industry data	List of installed equipment and upgrades from General Electric, Siemens, and Toshiba
Canadian population data	Population data for Canada and the provinces from Statistics Canada
International comparison data	International comparison data for the number of computed tomography and magnetic resonance imaging units and computed tomography and magnetic resonance imaging exams from the website of the Organisation for Economic Co-operation and Development

Table 2: Use of Data Sets in Analyses

Data Summaries	Data Sources						
	CMII 2017 Survey	CMII 2015 Survey[a,b]	CIHI 2012 Data[c]	Validation Data	Industry Data	Statistics Canada	International Data[d]
Summaries of site characteristics	•	•					
Summaries of modality availability, number of units	•	•		•	•		
Summary of planned installations and planned decommissioning	•						
Summary of units at sites that had responses to the 2015 survey but no responses or validation data for the CMII 2017 surveya		•					
Maps of machine locations	•	•		•	•		
Summaries of exams in one fiscal year	•	•		•			
Summaries of average hours per week and hours per day of operation, summaries of proportions of types of use	•	•					
Summaries of units per site and units per population	•	•		•	•	•	
Comparisons of inventory with international availability for CT and MRI	•	•		•	•		•
Age of units, current and decommissioned	•	•	•		•		
Technical specifications of current units	•	•	•		•		

CMII = Canadian Medical Imaging Inventory; CT = computed tomography; MRI = magnetic resonance imaging.

[a] Sites that had a response to the 2015 survey, but not the 2017 survey, identified by the lack of receipt of a submission form for the 2017 survey, or of correspondence indicating no change or describing changes.

[b] These data included responses from site survey responses, supplemented by data validators, and a supplementary grey literature search conducted for the 2015 report.

[c] From the data set originally supplied to CADTH by the Canadian Institute for Health Information, comprising data collected between 2003 and 2012, as described in the 2015 CMII report.[11]

[d] International data from the Organisation for Economic Co-operation and Development (OECD).[12-15]

Data Summaries

We present the data using descriptive summaries and graphs of site- and province-level findings. We use counts for discrete data, such as the number of sites with a given modality or the number of units at a site. Continuous values are presented either as summary statistics such as mean (average), or range between minimum and maximum values, or as assigned categories (e.g., hours of use per day as less than eight hours, eight to less than 12 hours, 12 to less than 18 hours, and 18 hours or more). Where we asked respondents to choose between two or more responses (e.g., Yes/No), we report the counts and/or percentages of respondents who selected each response.

Stacked bar charts were used to display number of units and hours and percentage of use as categories. The geographical distribution of modalities was presented using geocoded data presented on maps.

The survey form also included a field to invite respondents to give additional detail from which we extracted information regarding decommissioning activities and sharing of mobile units.

Missing Data and Imputation

Handling of Data From Sites Without Updated Data in 2017

If the 2017 survey was not updated for a site, we assumed there was no change from 2015 data. We carried forward data from previous surveys according to the following rules:

- Data for site characteristics, PACS use, unit and modality availability, counts, age, technical information, and use collected during the CMII 2015 survey were carried forward unchanged.
- Data for unit technical specifications collected up to 2012 were used in data summaries for age and technical information, provided the unit had not been identified as surplus to validated counts.
- Data for site characteristics, PACS use, unit and modality availability and counts, and modality use collected up to 2012 were not incorporated into data summaries unless they were confirmed in 2015 or 2017 (e.g., for unit counts, by comparison with validators' data).

Imputation of Missing Data

We imputed data for a limited number of missing values. In particular, if the questions regarding planned installations or decommissioning were left blank, we assumed the answer was "no." If the completed use categories added up to 100%, then any missing values were assumed to be 0%. Out-of-range values for the number of hours of operation per week (>168 hours) or per day (>24 hours) were set to "missing."

Imputation of Missing Examination Data

By preference, examination data supplied by the validators was reported. If we did not have validators' data for a given province, then data from the survey were used. When sites with available unit counts were missing data for the total number of examinations for 2017, we imputed the missing data, according to the following rules:

- Within each province or territory, we calculated the mean number of exams per unit for sites that reported examination data, and used this mean to impute the total number of exams for the remaining units. The total number of exams for each province or territory was the sum of the exams reported and exams imputed.
- The national total for Canada was the overall sum of reported and imputed examinations for all provinces and territories.
- Provinces or territories that had no examination data did not contribute to the Canadian total, even if they had units.

Results

Response Rate for the 2017 Update

A survey response was received (survey was submitted as final) for 147 sites, indicating either that available data had been reviewed and updated for 2017, or that new data had been entered. An additional 223 surveys were accessed and modified by respondents after the opening of the survey on April 18, 2017, but had not been submitted as final by the survey's close on June 9, 2017. Provincial and territorial validators provided information for non-responding publicly funded health facilities. At least minimal data (modalities and unit counts) were available for a total of 505 sites.

By comparison, 222 completed initial surveys were received for the 2015 CMII (respondents had to enter all data), which were supplemented with data from the 2012 CIHI survey, validators, and the results of a CADTH survey on the use of PET and PET-CT in Canada. At least minimal data (modalities and unit counts) were available for a total of 460 sites.

Characteristics of Facilities Responding to the 2017 Update

Of the 324 sites (of a total of 505 sites) with known facility type, most were identified as hospitals, accounting for 209 (64.5%) of reported sites, whereas 53 (16.4%) were community hospitals, 40 (12.3%) were free-standing facilities, and 22 (6.8%) were tertiary care centres (Appendix C, Table 18 shows summaries by province or territory). A facility was defined as a single hospital or hospital campus site that was part of an amalgamation of hospitals. The definition of free-standing facility was broad and captured privately funded and publicly funded sites, as well as sites that received both types of funding. See Appendix B for the detailed definitions of facility type.

Of the 223 sites that provided setting information, most self-reported that they were urban (154 or 69.1%), while 64 (28.7%) were rural, and 5 (2.2%) were remote (Appendix C, Table 19 shows summaries by province or territory).

Of the 329 sites that provided funding information, most were publicly funded (292 or 88.8%), while 27 (8.2%) were privately funded, and 10 (3%) received both public and private funding (Appendix C, Table 20 shows summaries by province or territory).

Overall Inventory of Medical Imaging Equipment in Canada in 2017

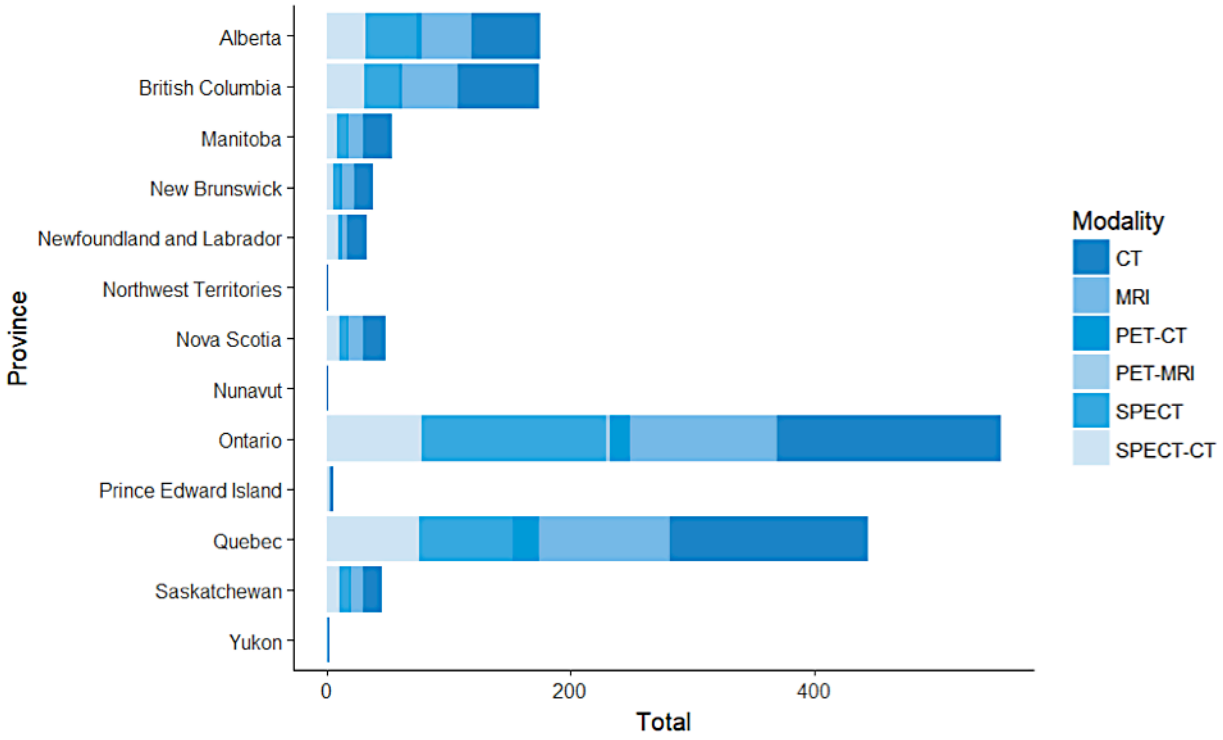
In this section, we briefly describe the overall reported inventory of units and use for the six imaging modalities of interest across all provinces and territories. Subsequent sections present in greater detail the inventory and use for CT, MRI, PET-CT, PET-MRI, SPECT, and SPECT-CT.

Total Unit Counts

Figure 1 and Table 3 show the overall provincial and territorial inventory of all six modalities.

Table 3 shows the total number of units per modality for each jurisdiction, as well as the number of sites with that modality available, based on survey responses, validators' and stakeholders' counts, and additional units identified in the CIHI survey as free-standing facilities.

Figure 1: Overall Provincial or Territorial Inventory of CT, MRI, PET-CT, PET-MRI, SPECT, and SPECT-CT in 2017



CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography– computed tomography.

Table 3: Overall Provincial or Territorial Inventory and Availability of CT, MRI, PET-CT, PET-MRI, SPECT, and SPECT-CT in 2017

Province / Territory	Number of Units[a] (Number of Sites With Units)[b]					
	CT	MRI	PET-CT	PET-MRI	SPECT	SPECT-CT
Alberta	56 (41)	41 (29)	4 (3)	0 (0)	42 (29)	32 (19)
British Columbia	66[d] (47)	46 (42)[d]	3[d] (2)	0 (0)	28 (16)	31 (18)
Manitoba	23 (16)	12 (7)	1 (1)	0 (0)	9 (6)	8 (5)
New Brunswick	15 (11)	11 (9)	2 (2)	0 (0)	5 (3)	5 (5)
Newfoundland and Labrador	16 (14)	5 (5)	1 (1)	0 (0)	2 (2)	9 (4)
Northwest Territories	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Nova Scotia	18 (14)	12 (11)	1 (1)	0 (0)	7 (7)	10 (8)
Nunavut	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Ontario	184 (105)	120 (74)	17[d] (14)	3 (3)	151 (74)	78 (48)
Prince Edward Island	2 (2)	1 (1)	0 (0)	0 (0)	0 (0)	2 (1)
Quebec	163[d] (97)	107[d] (75)	21[d] (20)	0 (0)	77[c] (39)	76[c] (42)
Saskatchewan	15 (13)	10 (7)	1 (1)	0 (0)	9 (4)	10 (5)
Yukon	1 (1)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Canada	561 (363)	366 (261)	51 (45)	3 (3)	330 (181)	261 (155)

CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography– computed tomography.

[a] Per-province unit counts according to the validator.

[b] Per-province unit availability according to the validator if the validator provided lists of sites with availability; otherwise, according to the survey.

[c] Validator-supplied combined unit counts for SPECT and SPECT-CT. Distribution was assumed to be 50:50, based on the division in Quebec and overall.

[d] Provincial totals included private units.

Growth in Inventory Over 2015–2017

There was an overall increase in the number of units for all modalities between 2015 and 2017 (see Table 28, Table 29, Table 30, and Table 31). The increase may represent a net increase in installation, but may also represent more complete data collection, due to the addition of industry and validator counts. This particularly applies to SPECT and SPECT-CT.

Number of Units by Provincial or Territorial Population

Table 4 shows the number of units reported per million people for all the provinces or territories and for Canada as a whole.

Table 4: CT, MRI, PET-CT, PET-MRI, SPECT, and SPECT-CT Units by Provincial or Territorial Population in 2017

Province / Territory	Population[a]	Number of Units[b] per Million Population[a]					
		CT	MRI	PET-CT	PET-MRI	SPECT	SPECT-CT
Alberta	4,291,980	13.05	9.55	0.93	0.00	9.79	7.46
British Columbia	4,789,221	13.78	9.60	0.63	0.00	5.85	6.47
Manitoba	1,332,629	17.26	9.00	0.75	0.00	6.75	6.00
New Brunswick	757,641	19.80	14.52	2.64	0.00	6.60	6.60
Newfoundland and Labrador	528,683	30.26	9.46	1.89	0.00	3.78	17.02
Northwest Territories	44,381	22.53	0.00	0.00	0.00	0.00	0.00
Nova Scotia	953,173	18.88	12.59	1.05	0.00	7.34	10.49
Nunavut	37,462	26.69	0.00	0.00	0.00	0.00	0.00
Ontario	14,135,610	13.02	8.49	1.20	0.21	10.68	5.52
Prince Edward Island	149,790	13.35	6.68	0.00	0.00	0.00	13.35
Quebec	8,371,498	19.47	12.78	2.51	0.00	9.20	9.08
Saskatchewan	1,161,365	12.92	8.61	0.86	0.00	7.75	8.61
Yukon	37,808	26.45	26.45	0.00	0.00	0.00	0.00
Canada	36,591,241	15.33	10.00	1.39	0.08	9.02	7.13

CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography– computed tomography.

[a] The population (estimated) as of July 1, 2017.[16]

[b] Per-province unit counts according to the validator.

Overall Number of Examinations

Table 5 shows the total number of examinations reported for all modalities across Canada for the most recent fiscal (or calendar) year for each site. Data from validators are reported, supplemented with survey data if validator data are unavailable (SPECT and SPECT-CT). Several jurisdictions combined SPECT and SPECT-CT exam data; therefore, an aggregated total is reported for these two modalities. A total of five exams were reported by a single site with PET-MRI. More detailed presentations of each modality appear in following sections, and the data are presented in Appendix D, Table 21.

Table 5: Total Examinations for the Latest Fiscal (or Calendar) Year for All Modalities Across Canada in 2017

Examinations	CT	MRI	PET-CT	SPECT and SPECT-CT
Exams reported by validatorsa	5,611,107	1,855,110	90,530	1,125,516
Additional exams estimated from survey datab	--	--	--	228,605
Number of unitsc	561	366	51	591
Exams per 1,000 peopled	153.0	51.0	2.0	37.0

CT = computed tomography; MRI = magnetic resonance imaging; PET-CT = positron emission tomography–computed tomography; SPECT = single-photon emission computed tomography; PET-CT = positron emission tomography–computed tomography.

[a] Validator reported exams were for public sites only.

[b] Data derived from survey question: "For all [modality] units, how many examinations on average were conducted in the last fiscal year." Number of exams for sites that did not report exams were imputed from the average for that province.

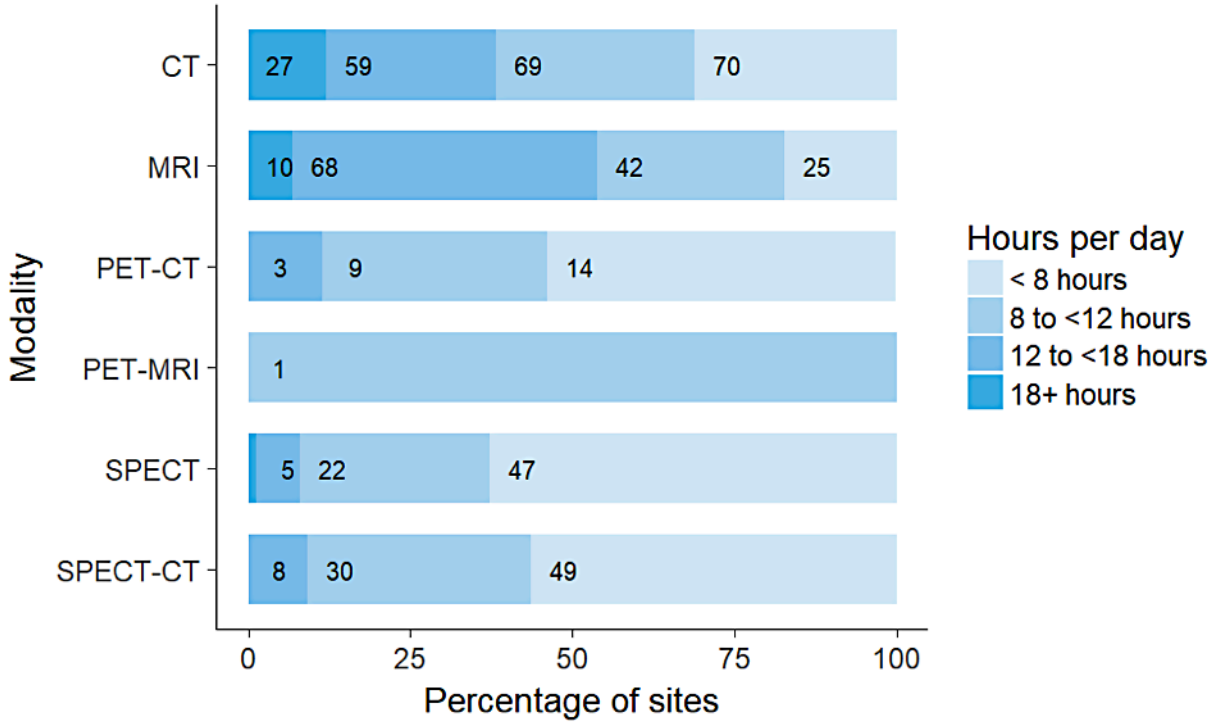
[c] Unit counts were those reported by validators.

[d] The population (estimated) as of April 1, 2017 (see Table 4).[16]

Overall Summary of Use: Hours per Day and Hours per Week

Figure 2 and Figure 3 show the pattern of use by hours per day and hours per week, respectively, for all sites with data available. The graph depicts the percentage of sites with units used less than eight hours a day, eight to less than 12 hours per day, 12 to less than 18 hours per day, and greater than 18 hours per day, and the bars are labelled with the number of sites in each category. CT is the most heavily used modality, followed by MRI.

Figure 2: Overall Hours of Use per Day for All Modalities: Percentage of Sites Reporting Specific Hours of Use in 2017



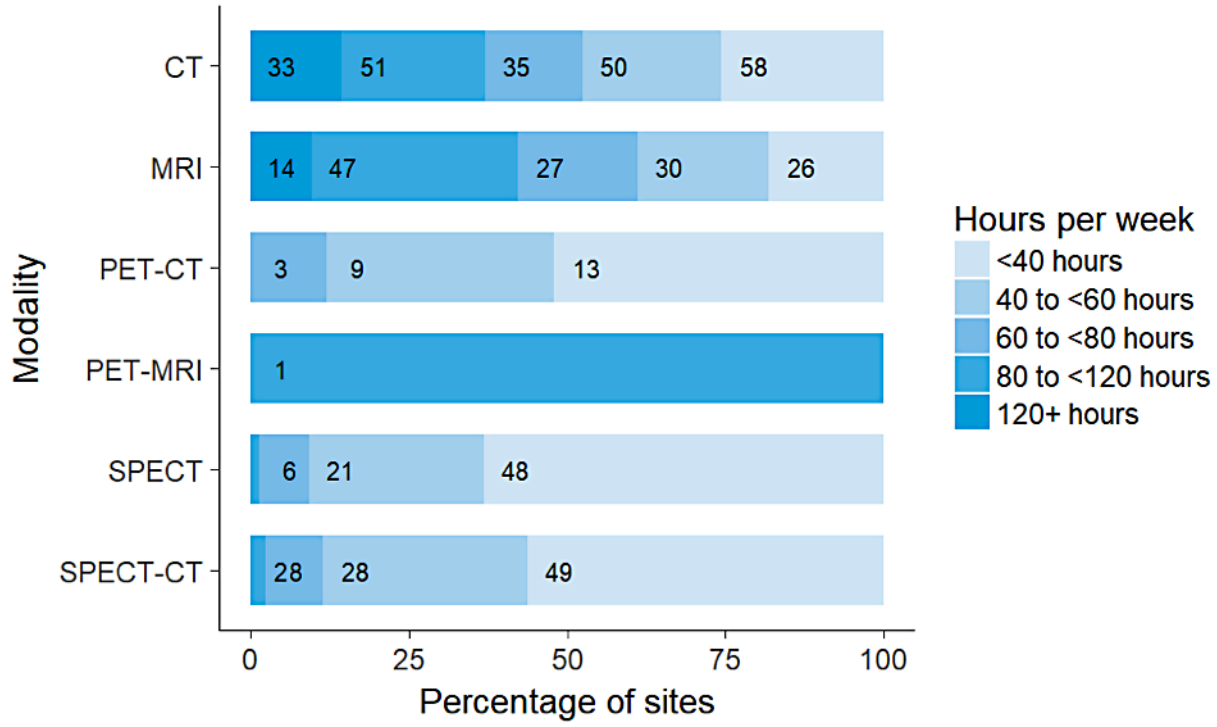
CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

Data derived from survey question: "In a regular 24-hour workday, how many hours are the [modality] units in use?"

Where 2017 data were not available, 2015 data were used, where available. Sites without data from 2015 or 2017 were not included in the figures.

Bars are labelled with the number of sites in each category.

Figure 3: Overall Hours of Use per Week for All Modalities: Percentage of Sites Reporting Specific Hours of Use in 2017



CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

Data derived from survey question: "In an average 168 hour week, how many hours are the [modality] units in use?"

Where 2017 data were not available, 2015 data were used, where available. Otherwise, no imputation was done, and the site was not included in the totals.

Bars are labelled with the number of sites in each category.

Overall Age of Units and Relationship of Age to Use

The age of imaging equipment was assessed, with the results presented in Table 6. The age of each unit was estimated by calculating the number of years since the first year of operation (i.e., 2017 – first year of operation). The age of imaging equipment that was identified as previously used in the survey could not be estimated. Therefore, these units are not included in the age cohorts, but are presented on their own. Information on a total of 1,615 units was retrieved. The age could be estimated in 83.5% of these units, 2.4% had been installed as previously used, and 14.2% of units did not have age data available. With the exception of SPECT, the majority of imaging equipment has 10 or fewer years of operation: 74.3% of CT units, 69.9% of MRI units, 84.2% of PET-CT units, and 87.6% SPECT-CT units (Table 6). In the case of SPECT, 42.5% of units are less than 10 years of age. SPECT is the only modality for which equipment installed more than 20 years ago is still in use (4.4%).

Table 6: Age of Units for All Modalities Across Canada, Numbers in 2017

Age of Units[a]	Number (and %)				
	CT	MRI	PET-CT	SPECT	SPECT-CT
0–5 years	167 (34.0)	115 (36.4)	12 (31.6)	41 (12.9)	73 (39.5)
6–10 years	198 (40.3)	106 (33.5)	20 (52.6)	94 (29.2)	89 (48.1)
11–15 years	114 (23.2)	84 (26.6)	6 (15.6)	115 (36.2)	22 (11.9)
16–20 years	12 (2.4)	11 (3.5)	0	54 (17.0)	1 (0.5)
>20 years	0	0	0	14 (4.4)	0
Used Units	15	11	2	8	2
Total	506	327	40	326	197

CT = computed tomography; MRI = magnetic resonance imaging; PET-CT = positron emission tomography–computed tomography; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

[a] Age for each unit calculated from survey question: "What year did (or will) the [modality] unit become operational?" subtracted from 2017.

Computed Tomography (CT)

Number and Location of CT Units

Three hundred and sixty-three sites in 13 provinces and territories have one or more CT units. There were up to nine units per site, for a total of 561 units. Ontario, Quebec, and British Columbia had the most CT units, and Nunavut, Northwest Territories, and Yukon the fewest, with one unit each. The number of units in provinces or territories with the modality ranges from 13.02 per million population in Ontario to 30.26 per million population in Newfoundland and Labrador, but this does not necessarily reflect accessibility, particularly in provinces and territories with large remote areas.

Eighty-eight new CT units were installed between 2015 and 2017. Thirty-four were replacement units for decommissioned units, 22 were new units, and 32 were not specified as new or replacement. Forty-six sites decommissioned one or more CT units (most decommissioned one unit) since the last survey in 2015, and 15 sites (of 147 sites with submitted surveys) reported planned installations of one or more CT units in the next two years (Table 7).

Table 7: Summary of Availability and Status of CT Units by Province in 2017

Province / Territory	Sites With Units[a]	Number of Units[b]	Sites Planning to Install[c]	Sites That Decommissioned Units Since 2015[d]	Units per Million Population[e]
Alberta	41	56	7	6	13.05
British Columbia	47[f]	66[f]	4	7	13.78
Manitoba	16	23	1	3	17.26
New Brunswick	11	15	0	2	19.80
Newfoundland and Labrador	14	16	0	3	30.26
Northwest Territories	1	1	0	1	22.53
Nova Scotia	14	18	0	1	18.88
Nunavut	1	1	0	0	26.69
Ontario	105	184	3	17	13.02
Prince Edward Island	2	2	0	1	13.35
Quebec	97[f]	163[f]	0	4	19.47
Saskatchewan	13	15	0	1	12.92
Yukon	1	1	0	0	26.45
Canada	363	561	15	46	15.33

CT = computed tomography.

[a] Data derived from number of units with technical details (make, model, first year of operation, and status as decommissioned/non-decommissioned), as provided by survey respondents to CMII and CIHI, and industry sources.

[b] Data obtained from provincial validators.

[c] Data derived from survey question: "Do you have plans to install the following in the next two years?" Data available from 147 submitted surveys.

[d] Data derived from survey question: "Has this unit been decommissioned?" if the year of decommissioning was 2015 or later.

[e] The population (estimated) as of July 1, 2017 (see Table 4).[16]

[f] Provincial totals included private units.

Geographical Distribution of CT Units

Figure 4 shows the present geographical distribution of CT units across Canada mapped to the level of settlement (city or town), with circle diameter proportional to the number of units. Counts for all sites within a city/town were aggregated.

Figure 4: Distribution of CT Units Across Canada in 2017

CT = computed tomography.

Availability and unit counts by site were derived from validator data if site-level data were available; otherwise, from survey data.
Mobile units appear as one unit at each of the sites served.

Mobile CT

Two CT units were identified as mobile units in urban Quebec. No information was available about whether they were shared between sites or operated as fixed units.

Number of Examinations in a Fiscal Year

Across Canada, an overall total of 5,611,107 CT examinations per year were reported for 561 units. Data quoted was supplied by provincial validators, at a provincial level, for either the latest fiscal or calendar year. The average number of exams per unit per year was 10,002. Table 8 shows the number of exams by province, and the number of exams per 1,000 people.

Table 8: Total Examinations per Fiscal Year for CT in 2017

Province / Territory	All Units[a]	Total Exams[b,c]	Population[d]	Exams per 1,000 Population
Alberta	56	405,332[e]	4,291,980	94.4
British Columbia	66	695,248	4,789,221	145.2
Manitoba	23	186,197	1,332,629	139.7
New Brunswick	15	142,294	757,641	187.8
Newfoundland and Labrador	16	90,985	528,683	172.1
Northwest Territories	1	4,695	44,381	105.8
Nova Scotia	18	155,099	953,173	162.7
Nunavut	1	2,000	37,462	53.4
Ontario	184	2,430,739	14,135,610	172.0
Prince Edward Island	2	15,811	149,790	105.6
Quebec	163	1,350,792	8,371,498	161.4
Saskatchewan	15	128,415	1,161,365	110.6
Yukon	1	3,500	37,808	92.6
Canada	561	5,611,107	36,591,241	153.0

CT = computed tomography.

[a] Data derived from number of units with technical details (make, model, first year of operation, and status as decommissioned/non-decommissioned).

[b] Validator-supplied data on examinations.

[c] Validator-supplied data for public sites only.

[d] The population (estimated) as of July 1, 2017 (see Table 4).[16]

[e] Exams from Alberta Health Services facilities only.

The reported examination data are summarized by province or territory in Appendix D, Table 21.

Typical Hours of Operation in a Week and Day, and All-Day and Weekend Use

Two hundred and twenty-five sites out of 363 provided data for the average number of hours per day that CT units were in use. Across all provinces or territories where a modality was available, CT units were used for an average of eight to 13.3 hours per day, depending on the province or territory (Appendix D, Table 22). Thirty-one per cent of units were used for less than eight hours per day, 30.7% were used for eight to less than 12 hours per day, 26.2% of units were used for 12 to less than 18 hours a day, and 12% of units were used for more than 18 hours per day. Sixty-five sites reported that at least one unit at their site was used for 24 hours a day (Appendix D, Table 23). We did not distinguish between scheduled and on-call availability in this question.

Two hundred and twenty-seven sites out of 363 provided data for the average number of hours per week that CT units were in use. Across all provinces or territories where a modality was available, CT units are used for an average of 40 to 88.3 hours per week (Appendix D, Table 24). Twenty-six per cent of units are used for less than 20 hours per week, 22% are used for 40 to less than 60 hours per week, 15.4% are used for 60 to less than 80 hours per week, 22.5% of units are used for 80 to less than 120 hours a week, and 14.5% of units are used for more than 120 hours per week. One hundred and seventy-five sites reported that at least one unit at their site is used on weekends (Appendix D, Table 25). We did not distinguish between scheduled and on-call availability in this question.

Types of CT Use

Survey participants were asked to provide the overall percentage of use for cardiac exams, non-cardiac exams, research, and any other type of use. Use breakdown was available for 159 sites. On average, the highest percentage of use for CT was non-cardiac, at 94.6% (use at individual sites ranged from 0% to 100%) followed by other, at 3.5% (range 0% to 100%), and cardiac, at 1.3% (range 0% to 15%). Details are available in Appendix D, Table 26.

Survey participants were asked to provide an overall percentage of use by discipline for CT. The categories included oncology, respiratory, hepatobiliary, musculoskeletal, inflammatory, neurological, cardiac, trauma, and other. Usage breakdown was available for 63 sites. On average, the highest percentage of use for CT was oncological exams, at 23.1% (use at individual sites ranged from 0% to 100%), followed by neurological, at 18.9% (range 0% to 55%), respiratory, at 12.6% (range 0% to 30%), and hepatobiliary exams, at 11.5% (range 0% to 35%). Details are available in Appendix D, Table 27. Due to the low response rate, data may not be representative of all sites.

Technical Characteristics of CT Units

The number of slices was available for 460 units. CTs with 64 slices (51.5%) are the most common, followed by those with 128 slices (13.2%) and 16 slices (13.2%; Table 9). Six per cent (5.8%) of units have more than 256 slices. Information on dual-energy options was available for 409 units. Almost a quarter (23.5%, 96/409) of CT units have a dual-energy option, which allows for the simultaneous acquisition of images at two different energies, as a means of enhancing images and reducing radiation exposure. Information on dual-target options was available for 209 units. A dual-target option is available in 12.9% (27/209) of CT units.

Table 9: Reported Number of Slices in CT Units in 2017

Slices	1	2	4	6	8	10	16	32
Number (%)	9 (2.0)	3 (0.7)	15 (3.2)	1 (0.2)	9 (2.0)	1 (0.2)	81 (13.2)	2 (0.4)
Slices	40	64	80	128	160	192	256	320
Number (%)	3 (0.7)	237 (51.5)	2 (0.4)	61 (13.2)	6 (1.3)	3 (0.7)	14 (3.0)	13 (2.8)

CT = computed tomography.
Data from question: "How many multidetectors does the CT unit have (how many slices)?"

The survey also asked about features intended to manage radiation safety. Three-quarters (77.2%, 183/237) of CT units incorporate image reconstruction techniques for dose reduction, and 91.6% (185/202) of CT units record patient radiation dose by exam. More than 80% (81.4%, 197/242) of CT units are equipped with dose-management controls, and 93.0% (160/172) of the survey responders reported use of these controls. Data for the others were missing.

Magnetic Resonance Imaging (MRI)

Number and Location of MRI Units

Two hundred and sixty-one sites in 11 provinces or territories have one or more MRI units. There were up to eight units per site, for a total of 366 units. Ontario, Quebec, and British Columbia had the most MRI units. Yukon is the only territory to have an MRI unit. The number of units per million population in provinces or territories with the modality ranges from 6.68 in Prince Edward Island to 26.45 in Yukon, but this does not necessarily reflect accessibility, particularly in provinces and territories with large remote areas.

Forty-six new MRI units were installed between 2015 and 2017. Six were replacement units for decommissioned units, 15 were new units, and 25 were not specified as new or replacement. Twelve sites decommissioned one or more MRI units (most decommissioned one unit) since the last survey in 2015, and nine sites (of 147 sites with submitted surveys) reported planned installations of one or more MRI units in the next two years (Table 10).

Table 10: Summary of Availability and Status of MRI Units by Province in 2017

Province / Territory	Sites With Unit(s)[a]	Number of Units[b]	Sites Planning to Install[c]	Sites That Decommissioned Units Since 2012[d]	Units per Million Population[e]
Alberta	29	41	2	3	9.55
British Columbia	42[f]	46[f]	1	0	9.60
Manitoba	7	12	1	1	9.00
New Brunswick	9	11	0	2	14.52
Newfoundland and Labrador	5	5	0	0	9.46
Northwest Territories	0	0	0	0	0.00
Nova Scotia	11	12	0	0	12.59
Nunavut	0	0	0	0	0.00
Ontario	74[f]	120[f]	5	2	8.49
Prince Edward Island	1	1	0	0	6.68
Quebec	75	107	0	4	12.78
Saskatchewan	7	10	1	0	8.61
Yukon	1	1	0	0	26.45
Canada	261	366	9	12	10.00

MRI = magnetic resonance imaging.

[a] Data derived from number of units with technical details (make, model, first year of operation, and status as decommissioned/non-decommissioned), as provided by survey respondents to CMII and CIHI, and by industry sources.

[b] Data obtained from provincial validators.

[c] Data derived from survey question: "Do you have plans to install the following in the next two years?" Data were available from 147 surveys.

[d] Data derived from survey question: "Has this unit been decommissioned?" if the year of decommissioning was 2015 or later.

[e] The population (estimated) as of July 1, 2017 (see Table 4).[16]

[f] Provincial totals included private units.

Geographical Distribution of MRI

Figure 5 shows the geographical distribution of MRI across Canada mapped to the level of settlement (city or town), with circle diameter proportional to the number of units. Counts for all sites within a city/town were aggregated.

Figure 5: Distribution of MRI Units Across Canada in 2017

MRI = magnetic resonance imaging.

Availability and unit counts by site were derived from validator data if site-level data were available; otherwise, from survey data.
Mobile units appear as one unit at each of the sites served.

Mobile MRI

Twenty-two sites indicated that they were served by mobile units, with two units in British Columbia, two in Quebec, and one each in Alberta and New Brunswick. In British Columbia, one mobile unit is shared by three facilities in the Okanagan and Kootenays, and another is shared by two facilities on Vancouver Island. The unit in New Brunswick is shared among five facilities. The unit in Alberta is shared by two facilities outside of Edmonton in Central Alberta. One unit in Quebec is shared by five facilities, all in the administrative region of Gaspésie–Îles-de-la-Madeleine, while the other is shared by three facilities in Abitibi-Témiscamingue.

Number of Examinations in a Fiscal Year

Across Canada, an overall total of 1,855,110 MRI examinations per year were reported for 366 units, with each site reporting its last fiscal (or calendar) year. The average number of exams per unit was 5,082. Table 11 shows the total number of exams by province and the number of exams per 1,000 people.

Table 11: Total Examinations per Fiscal Year for MRI in 2017

Province / Territory	All Units[a]	Total Exams[b,c]	Population	Exams per 1,000 Population[d]
Alberta	41	192,375[e]	4,291,980	44.8
British Columbia	46	173,678	4,789,221	36.3
Manitoba	12	77,735	1,332,629	58.3
New Brunswick	11	44,592	757,641	58.9
Newfoundland and Labrador	5	20,990	528,683	39.7
Northwest Territories	0	NA	44,381	NA
Nova Scotia	12	47,490	953,173	49.8
Nunavut	0	NA	37,462	NA
Ontario	120	866,953	14,135,610	61.3
Prince Edward Island	1	4,279	149,790	28.6
Quebec	107	380,357	8,371,498	45.4
Saskatchewan	10	44,461	1,161,365	38.3
Yukon	1	2,200	37,808	58.2
Canada	366	1,855,110	36,591,241	51.0

NA = not applicable.

[a] Data derived from number of units with technical details (make, model, first year of operation, and status as decommissioned/non-decommissioned).

[b] Exams supplied by provincial validators.

[c] Validator-supplied data were for public sites only.

[d] The population (estimated) as of July 1, 2017 (see Table 4).[16]

[e] Exams from Alberta Health Services facilities only.

The reported examination data are summarized by province or territory in Appendix D, Table 21.

Typical Hours of Operation in a Week and Day, and All-Day and Weekend Use

One hundred and forty-five sites (145) out of 261 provided data for the average number of hours per day that MRI units were in use. Across all provinces or territories where a modality was available, MRI units were used for an average of 9 to 16.2 hours per day, depending on the province or territory (Appendix D, Table 22). Seventeen per cent of units were used for less than eight hours per day, 29% were used for eight to less than 12 hours per day, 46.9% of units were used for 12 to less than 18 hours a day, and 6.9% of units were used for more than 18 hours per day. Eleven sites reported that at least one unit at their site was used for 24 hours a day (Appendix D, Table 23). We did not distinguish between scheduled and on-call availability in this question.

One hundred and forty-four sites out of 261 provided data for the average number of hours per week that MRI units were in use. Across all provinces or territories where a modality was available, MRI units were used for an average of 40 to 108.6 hours per week (Appendix D, Table 24). Eighteen per cent of units were used for less than 20 hours per week, 20.8% were used for 40 to less than 60 hours per week, 18.8% were used for 60 to less than 80 hours per week, 32.6% of units were used for 80 to less than 120 hours a week, and 9.7% of units were used for more than 120 hours per week. Eighty-three sites reported that at least one unit at their site was used at weekends (Appendix D, Table 25). We did not distinguish between scheduled and on-call availability in this question.

Types of MRI Use

Survey participants were asked to provide the overall percentage of use for cardiac exams, non-cardiac exams, research, and any other type of use. Use breakdown was available for 86 sites. On average, the highest percentage of use for MRI was non-cardiac exams, at 85.7% (use at individual sites ranged from 0% to 100%) followed by other uses, at 4.3% (range 0% to 100%) and cardiac exams, at 3.5% (range 0% to 50%). Details are available in Appendix D, Table 26.

Survey participants were asked to provide the overall percentage of use by discipline for MRI. The categories included oncology, cardiac, respiratory, hepatobiliary, musculoskeletal, neurological, trauma, and other uses. Use breakdown was available for 34 sites. On average, the highest percentage of use for MRI was musculoskeletal use, at 27.3% (use at individual sites ranged 0% to 70%), followed by neurological use, at 25.4% (range 0% to 45%), oncology use, at 20.8% (range 0% to 100%), and hepatobiliary use, at 11.3% (range 0% to 25%). Details are available in Appendix D, Table 27. Due to the low response rate, data may not be representative of all sites.

Technical Characteristics of MRI Units

For all MRIs with available information on field strength (321 units), the majority (267, 83.2%) operate with a 1.5 Tesla (T) magnetic field strength. The second most common field strength is 3.0 T (13.7%). The remaining MRI units used field strengths of 0.3 T (0.3%), 0.35 T (0.3%), 1.0 T (1.6%), 4.0 T (0.3%), 5.0 T (0.3%), and 9.4 T (0.3%). Data on MRI configuration were available for 170 units. The survey indicates 6.5%, 55.3%, and 38.2% of MRI units use an open bore, closed bore, and wide bore, respectively.

Positron Emission Tomography–Computed Tomography (PET-CT) or Positron Emission Tomography (PET)

Number and Location of PET-CT or PET Units

Forty-five sites in nine provinces have one or more PET-CT units. There are up to two units per site, for a total of 51 units. Quebec, Ontario, and Alberta have the most PET-CT units, and Prince Edward Island and the three territories do not have any units. Although we asked about PET-CT or PET, findings of a recent CADTH Environmental Scan[17] suggest these units are almost exclusively PET-CT, since stand-alone PET units have not been available for purchase in Canada for the past decade. Therefore, this category is referred to as PET-CT, except when quoting survey questions. The number of units per million population in provinces or territories with the modality ranges from 0.63 in British Columbia to 2.64 in New Brunswick, but this does not necessarily reflect accessibility, particularly in provinces and territories with large remote areas.

One new PET-CT unit was installed between 2015 and 2017. No sites decommissioned a PET-CT unit, and two sites (of 147 submitted surveys) reported planned installations of one or more PET-CT units in the next two years (Table 12).

Table 12: Summary of Availability and Status of PET-CT Units by Province in 2017

Province / Territory	Sites With Units[a]	Number of Units[b]	Sites Planning to Install[c]	Sites That Decommissioned Units Since 2012[d]	Units per Million Population[e]
Alberta	3	4	1	0	0.93
British Columbia	2[f]	3[f]	1	0	0.63
Manitoba	1	1	0	0	0.75
New Brunswick	2	2	0	0	2.64
Newfoundland and Labrador	1	1	0	0	1.89
Northwest Territories	0	0	0	0	0.00
Nova Scotia	1	1	0	0	1.05
Nunavut	0	0	0	0	0.00
Ontario	14[f]	17[f]	0	0	1.20
Prince Edward Island	0	0	0	0	0.00
Quebec	20[f]	21[f]	0	0	2.51
Saskatchewan	1	1	0	0	0.86
Yukon	0	0	0	0	0.00
Canada	45	51	2	0	1.39

PET-CT = positron emission tomography–computed tomography.

[a] Data derived from number of units with technical details (make, model, first year of operation, and status as decommissioned/non-decommissioned), as provided by survey respondents to CMII and CIHI, and by industry sources.

[b] Data obtained from provincial validators.

[c] Data derived from survey question: "Do you have plans to install the following in the next two years?" Data available from 147 surveys.

[d] Data derived from survey question: "Has this unit been decommissioned?" if the year of decommissioning was 2015 or later.

[e] The population (estimated) as of July 1, 2017 (see Table 4).[16]

[f] Provincial totals include private units.

Geographical Distribution of PET-CT

Figure 6 shows the present geographical distribution of PET-CT across Canada mapped to the level of settlement (city or town), with circle diameter proportional to the number of units. Counts for all sites within a city/town were aggregated.

Figure 6: Distribution of PET-CT Across Canada in 2017

PET-CT = positron emission tomography–computed tomography.
Availability and unit counts by site were derived from validator data if site-level data were available; otherwise, from survey data.

Number of Examinations in a Fiscal Year

Across Canada, an overall total of 90,530 PET-CT examinations per year were reported for 51 units, with each site reporting its last fiscal year. The average number of exams per unit was 1,775. Table 13 shows the total number of exams by province and the number of exams per 1,000 people.

Table 13: Reported and Imputed Total Examinations per Fiscal Year for PET-CT in 2017

Province / Territory	All Units[a]	Total Exams[b,c]	Population	Exams per 1,000 Population[d]
Alberta	4	11,050[e]	4,291,980	2.6
British Columbia	3	9,280	4,789,221	1.9
Manitoba	1	2,009	1,332,629	1.5
New Brunswick	2	1,808	757,641	2.4
Newfoundland and Labrador	1	0	528,683	0.0
Northwest Territories	0	NA	44,381	NA
Nova Scotia	1	2,512	953,173	2.6
Nunavut	0	NA	37,462	NA
Ontario	17	10,998	14,135,610	0.8
Prince Edward Island	0	NA	149,790	NA
Quebec	21	50,823	8,371,498	6.1
Saskatchewan	1	2,050	1,161,365	1.8
Yukon	0	NA	37,808	NA
Canada	51	90,530	36,591,241	2.0

NA = not applicable; PET-CT = positron emission tomography–computed tomography.

[a] Data derived from number of units with technical details (make, model, first year of operation, and status as decommissioned/non-decommissioned).

[b] Exams supplied by provincial validators.

[c] Validator-supplied data were for public sites only.

[d] The population (estimated) as of July 1, 2017 (see Table 4).[16]

[e] Exams from Alberta Health Services facilities only.

The reported examination data, without imputation, are summarized by province or territory in Appendix D, Table 21.

Typical Hours of Operation in a Week and Day, and All-Day and Weekend Use

Twenty-six of 45 sites provided data for the average number of hours per day that PET-CT units were in use. Across all provinces where a modality was available, PET-CT units were used for an average of six to 14.5 hours per day, depending on the province (Appendix D, Table 22). Fifty-four per cent of units were used for less than eight hours per day, 34.6% were used for eight to less than 12 hours per day, and 11.5% of units were used for 12 to less than 18 hours a day. No sites reported 24 hours-a-day operation (Appendix D, Table 23). We did not distinguish between scheduled and on-call availability in this question.

Twenty-five of 45 sites provided data for the average number of hours per week that PET-CT units were in use. Across all provinces where a modality was available, PET-CT units were used for an average of 18 to 79 hours per week (Appendix D, Table 24). Fifty-two per cent of units were used for less than 20 hours per week, 36% were used for 40 to less than 60 hours per week, and 12% were used for 60 to less than 80 hours per week. Two sites reported that at least one unit at their site was used at weekends (Appendix D, Table 25). We did not distinguish between scheduled and on-call availability in this question.

Type of PET-CT Use

Survey respondents were asked to provide the overall percentage of use for cardiac exams, non-cardiac exams, research, and any other type of use. Use breakdown was available for 19 sites. On average, the highest percentage of use for PET-CT was non-cardiac exams, at 80.7% (use at individual sites ranged from 20% to 100%), followed by cardiac exams, at 12.1% (range 0% to 80%) and research use, at 6.8% (range 0% to 50%). Details are available in Appendix D, Table 26.

Survey respondents were asked to provide the overall percentage of use by discipline for PET-CT. The categories were oncology, cardiac, inflammatory, neurology, and other. The breakdown of use was available for 13 sites. On average, the highest percentage of use for PET-CT was oncology use, at 80.2% (use at individual sites ranged from 0% to 100%) followed by cardiac use, at 10.7% (range 0% to 95%), neurological use, at 7% (range 0% to 50%), and inflammatory use, at 1.2% (range 0% to 5%). Details are available in Appendix D, Table 27. Due to the low response rate, data may not be representative of all sites.

Technical Characteristics of PET-CT Units

The number of detector row slices available in the CT component of these PET-CT machines was available for 37 units. Sixteen slices is the most common number (67.6%), followed by 64 slices (21.6%) and 40 slices (5.4%). No PET-CTs are used exclusively for head imaging. The CT component is used independently (i.e., to provide extra CT capacity) in 40.0% (6/15) of units answering this question.

The survey also asked about features intended to manage radiation safety. Of the 24 units with responses available to that question, 87.5% are equipped with dose-management controls, and, of those, 90.0% (18/20) reported use of these controls. Data for the others were missing. Two-thirds (14/21) of PET-CTs incorporate image reconstruction techniques for dose reduction, and 77.3% (17/22) of PET-CT units record patient radiation dose per exam.

Isotope Supply for PET Hybrid Modalities

We asked sites reporting a PET-CT whether they have access to a cyclotron, and, if not, where they obtain isotopes. Of the 19 sites who responded to the question, eight have access to a local cyclotron. The Canadian Nuclear Safety Commission website identified a total of 10 PET cyclotrons in Canada.[18]

Nine sites of the 18 sites without a cyclotron reported obtaining isotopes elsewhere, the majority from commercial suppliers (6). The remainder obtained isotopes from other sites with cyclotrons (2) or did not indicate a source (10).

Positron Emission Tomography-MRI (PET-MRI)

Number and Location of PET-MRI Units

Three sites in Ontario had one PET-MRI unit each.

One new PET-MRI unit was installed between 2015 and 2017.

Figure 7: Distribution of PET-MRI units across Canada in 2017

PET-MRI = positron emission tomography–magnetic resonance imaging.

Patterns of PET-MRI use

All units are currently for research use only. However, five examinations were reported for one unit.

Technical Characteristics of PET-MRI

Three PET-MRIs were identified in the survey. No information on the imaging scope or mobility of these units was available.

Single-Photon Emission Computed Tomography (SPECT)

Number and Location of SPECT Units

One hundred and eighty-one sites in nine provinces have one or more SPECT units. There are up to nine units per site, for a total of 330 units. Ontario, Quebec, and Alberta have the most SPECT units, while Prince Edward Island and the three territories have none. The number of units per million population in provinces or territories with SPECT ranges from 3.78 in Newfoundland and Labrador to 10.68 in Ontario, but this does not necessarily reflect accessibility, particularly in provinces and territories with large remote areas.

Thirteen new SPECT units were installed between 2015 and 2017. Three were replacement units for decommissioned units, two were new units, and eight were not specified as new or replacement. Eighteen sites decommissioned one or more SPECT units (most decommissioned one unit) since the last survey in 2015, and three sites (of 147 sites that submitted surveys) reported planned installations of one or more SPECT units in the next two years (Table 14).

Table 14: Summary of Availability and Status of SPECT Units by Province in 2017

Province / Territory	Sites With Units[a]	Number of Units[b]	Sites Planning to Install[c]	Sites That Decommissioned Units Since 2012[d]	Units per Million Population[e]
Alberta	29	42	2	1	9.79
British Columbia	16	28	1	3	5.85
Manitoba	6	9	0	1	6.75
New Brunswick	3	5	0	0	6.60
Newfoundland and Labrador	2	2	0	1	3.78
Northwest Territories	0	0	0	0	0.00
Nova Scotia	7	7	0	1	7.34
Nunavut	0	0	0	0	0.00
Ontario	74	151[f]	0	9	10.68
Prince Edward Island	0	0	0	0	0.00
Quebec	39[g]	77[g]	0	2	9.20
Saskatchewan	4	9	0	0	7.75
Yukon	0	0	0	0	0.00
Canada	181	330	3	18	9.02

SPECT = single-photon emission computed tomography.

[a] Data derived from number of units with technical details (make, model, first year of operation, and status as decommissioned/non-decommissioned), as provided by survey respondents to CMII and CIHI, and by industry sources.

[b] Data obtained from provincial validators.

[c] Data derived from survey question: "Do you have plans to install the following in the next two years?" Data available from 147 submitted surveys.

[d] Data derived from survey question: "Has this unit been decommissioned?" if the year of decommissioning was 2015 or later.

[e] The population (estimated) as of July 1, 2017 (see Table 4).[16]

[f] Validator-supplied combined unit counts for SPECT and SPECT-CT. Distribution was assumed to be 50:50, based on the division in Quebec and overall.

[g] Provincial totals included private units.

Geographical Distribution of SPECT

Figure 8 shows the present geographical distribution of SPECT across Canada mapped to the level of settlement (city or town), with circle diameter proportional to the number of units. Counts for all sites within a city/town were aggregated.

Figure 8: Distribution of SPECT Across Canada in 2017

SPECT = single-photon emission computed tomography.

Availability and unit counts by site were derived from validator data if site-level data were available; otherwise, from survey data.
Mobile units appear as one unit at each of the sites served.

Mobile SPECT

Four SPECT units at three sites in Ontario were identified as mobile units. Three were multifunctional, and one was a dedicated cardiac unit. There was no information on whether the units were shared among the identified sites, or were operated as fixed units.

Number of Examinations in a Fiscal Year: SPECT

For several provinces, validators supplied aggregated information for SPECT and SPECT-CT only; therefore, examination data are summarized for both SPECT and SPECT-CT in the section on SPECT-CT (Table 16).

Typical Hours of Operation by Week and Day, and All-Day and Weekend Use

Seventy-five of 181 sites provided data for the average number of hours per day that SPECT units were in use. Across all provinces where a modality was available, SPECT units were used for an average of seven to 9.9 hours per day, depending on the province (Appendix D, Table 22). Sixty-three per cent of units were used for less than eight hours per day, 29.3%

were used for eight to less than 12 hours per day, 6.7% of units were used for 12 to less than 18 hours a day, and 1.3% of units were used for more than 18 hours per day. No sites reported that at least one unit at their site was used for 24 hours a day (Appendix D, Table 23). We did not distinguish between scheduled and on-call availability in this question.

Seventy-six of 181 sites provided data for the average number of hours per week that SPECT units were in use. Across all provinces or territories where a modality was available, SPECT units were used for an average of 35 to 49.4 hours per week (Appendix D, Table 24). Sixty-three per cent of units were used for less than 20 hours per week, 27.6% were used for 40 to less than 60 hours per week, 7.9% were used for 60 to less than 80 hours per week, and 1.3% of units were used for 80 to less than 120 hours a week. Nine sites reported that at least one unit at their site was used on weekends (Appendix D, Table 25). We did not distinguish between scheduled and on-call availability in this question.

Types of SPECT Use

Survey respondents were asked to provide the overall percentage of use for cardiac exams, non-cardiac exams, research, and any other type of use for all units at their site. Use breakdown was available for 50 sites. On average, the highest percentage of use for SPECT was non-cardiac exams, at 73.9% (use at individual sites ranged from 0% to 100%), followed by cardiac exams, at 26.3% (range 0% to 100%), and research use, at 0.3% (range 0% to 10%). Details are available in Appendix D, Table 26.

Survey respondents were asked to provide the overall percentage of use by discipline for SPECT for all units at their site. For SPECT, the categories were oncology, cardiac, inflammatory, neurological, and other use. The breakdown of use by discipline was available for 19 sites. On average, the highest percentage of use for SPECT was cardiac exams, at 39.8% (use at individual sites ranged 0% to 100%), followed by oncology use, at 24.7% (range 0% to 100%), musculoskeletal use, at 10.4% (range 0% to 48%), and respiratory use, at 7.2% (range 0% to 65%). Details are available in Appendix D, Table 27. Due to the low response rate, data may not be representative of all sites, as suggested by the difference between cardiac use captured by this question, and cardiac use reported for the breakdown of use by cardiac, non-cardiac, and other use, abovementioned.

Technical Characteristics of SPECT Units

The number of detector heads was reported for 83 units, with two detector heads being the most common configuration (73.5%), followed by one (18.1%), three (7.2%), and six (1.2%). CT capability of one- to 64-slice resolution was reported for 37 units. Of the 90 units with the information available, a quarter (24.4%) are dedicated cardiac imaging units, with the remaining 75.6% having multipurpose or non-cardiac use. Note that the section on use reports average use for all units at a site. Field of view was reported for 77 units, with 14.3%, 84.4%, and 1.3% using a dedicated limited, multipurpose, or other view, respectively. SPECT units generally use one of two types of software to generate images: filtered projection or iterative reconstruction. Of the 66 units with available information, 48.5% use filtered projection software, and 51.5% use interactive reconstruction.

Single-Photon Emission Computed Tomography–Computed Tomography (SPECT-CT)

Number and Location of SPECT-CT Units

One hundred and fifty-five sites in 10 provinces or territories have one or more SPECT-CT units. There are up to six units per site, for a total of 261 units. Ontario, Quebec, and Alberta have the most SPECT-CT units. The number of units per million population in provinces or territories with the modality ranges from 5.52 in Ontario to 17.02 to Newfoundland and Labrador, but this does not necessarily reflect accessibility, particularly in provinces and territories with large remote areas.

Thirty-seven new SPECT-CT units were installed between 2015 and 2017. Three were replacement units for decommissioned units, 13 were new units, and 21 were not specified as new or replacement. No sites decommissioned any SPECT-CT units since the last survey in 2015, and five sites (of 147 sites with submitted surveys) reported planned installations of one or more SPECT-CT units in the next two years (Table 15).

Table 15: Summary of Availability and Status of SPECT-CT Units by Province in 2017

Province / Territory	Sites With Units[a]	Number of Units[b]	Sites Planning to Install[c]	Sites That Decommissioned Units Since 2012[d]	Units per Million Population[e]
Alberta	19	32	1	0	7.46
British Columbia	18	31	0	0	6.47
Manitoba	5	8	0	0	6.00
New Brunswick	5	5	1	0	6.60
Newfoundland and Labrador	4	9	0	0	17.02
Northwest Territories	0	0	0	0	0.00
Nova Scotia	8	10	0	0	10.49
Nunavut	0	0	0	0	0.00
Ontario	48	78	3	0	5.52
Prince Edward Island	1	2	0	0	13.35
Quebec	42	76	0	0	9.08
Saskatchewan	5	10	0	0	8.61
Yukon	0	0	0	0	0.00
Canada	155	261	5	0	7.13

SPECT-CT = single-photon emission computed tomography–computed tomography.

[a] Data derived from number of units with technical details (make, model, first year of operation, and status as decommissioned/non-decommissioned) as provided by survey respondents to CMII and CIHI, and by industry sources.

[b] Data obtained from provincial validators.

[c] Data derived from survey question: "Do you have plans to install the following in the next two years?" Data available from 147 submitted surveys.

[d] Data derived from survey question: "Has this unit been decommissioned?" if the year of decommissioning was 2015 or later.

[e] The population (estimated) as of July 1, 2017 (see Table 4).[16]

[f] Validator-supplied combined unit counts for SPECT and SPECT-CT. Distribution was assumed to be 50:50, based on the division in Quebec and overall.

Geographical Distribution of SPECT-CT

Figure 9 shows the present geographical distribution of SPECT-CT across Canada mapped to the level of settlement (city or town), with circle diameter proportional to the number of units. Counts for all sites within a city/town were aggregated.

Figure 9: Distribution of SPECT-CT across Canada in 2017

SPECT-CT = single-photon emission computed tomography–computed tomography.

Availability and unit counts by site were derived from validator data if site-level data were available; otherwise, from survey data.
Mobile units appear as one unit at each of the sites served.

Number of Examinations in a Fiscal Year: SPECT and SPECT-CT

For several provinces, validators supplied aggregated information for SPECT and SPECT-CT only. Data as provided are shown in Appendix D, Table 21. For the purposes of summary, exams for SPECT and SPECT-CT are pooled for all provinces. Across Canada, an overall total of 1,354,121 examinations per year were reported for 591 SPECT and SPECT-CT units, with each site reporting its last fiscal year. The average number of exams per unit was 2,273. Table 16 shows the total number of SPECT and SPECT-CT exams by province, and the number of exams per 1,000 people.

Table 16: Reported and Imputed Total Examinations per Fiscal Year for SPECT and SPECT-CT in 2017

Province / Territory	All Units[a]	Total Exams[b,c]	Population	Exams per 1,000 Population[d]
Alberta	74	26,130[e]	4,291,980	6.1
British Columbia	59	148,578[f]	4,789,221	31.0
Manitoba	17	22,074	1,332,629	16.6
New Brunswick	10	39,635	757,641	52.3
Newfoundland and Labrador	11	49,835	528,683	94.3
Nova Scotia	17	25,413[f]	953,173	26.7
Nunavut	0		37,462	
Northwest Territories	0		44,381	
Ontario	229	200,833	14,135,610	14.2
Prince Edward Island	2	2,299	149,790	15.3
Quebec	153	786,594	8,371,498	94.0
Saskatchewan	19	52,730[f,g]	1,161,365	45.4
Yukon	0		37,808	
Canada	591	1,354,121	36,591,241	37.0

SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

[a] Data derived from number of units with technical details (make, model, first year of operation, and status as decommissioned/non-decommissioned).

[b] Validator-supplied from provincial validators, unless otherwise noted.

[c] Validator-supplied data were for public sites only.

[d] The population (estimated) as of July 1, 2017.[16]

[e] Exams from Alberta Health Services facilities only.

[f] No validator data for the province (British Columbia and Saskatchewan) or a health region (NS). Values imputed from available survey data.

[g] SPECT-CT data available, only.

Typical Hours of Operation in a Week and Day, and All-Day and Weekend Use

Eighty-seven of 157 sites provided data for the average number of hours per day that SPECT-CT units were in use. Across all provinces or territories where a modality was available, SPECT-CT units were used for an average of seven to 10.8 hours per day, depending on the province (Appendix D, Table 22). Fifty-six per cent of units were used for less than eight hours per day, 34.5% were used for eight to less than 12 hours per day, and 9.2% of units were used for 12 to less than 18 hours a day. No sites have 24-hour use (Appendix D, Table 23). We did not distinguish between scheduled and on-call availability in this question.

Eighty-seven of 157 sites provided data for the average number of hours per week that SPECT-CT units were in use. Across all provinces or territories where a modality was available, SPECT-CT units were used for an average of 35 to 54 hours per week (Appendix D, Table 24). Fifty-six per cent of units were used for less than 20 hours per week, 32.2% were used for 40 to less than 60 hours per week, 9.2% were used for 60 to less than 80 hours per week, and 2.3% of units were used for 80 to less than 120 hours a week. Nine sites reported that at least one unit at their site was used on weekends (Appendix D, Table 25). We did not distinguish between scheduled and on-call availability in this question.

Types of SPECT-CT Use

Survey respondents were asked to provide the overall percentage of use for cardiac exams, non-cardiac exams, research, and any other type of use. Use breakdown was available for 55 sites. On average, the highest percentage of use for SPECT-CT was non-cardiac uses, at 78.1% (use for individual sites ranged from 15% to 100%), followed by cardiac uses, at 21.6% (range 0% to 85%) and other uses, at 0.2% (range 0% to 10%). Details are available in Appendix D, Table 26.

Survey respondents were asked to provide the overall percentage of use by discipline. For SPECT-CT, the categories were oncology, cardiac, hepatobiliary, inflammatory, lymphatic, musculoskeletal, neurological, respiratory, thyroid, and other uses. The breakdown of use was available for 15 sites. On average, the highest percentage of use for SPECT-CT was cardiac use, at 35.7% (use for individual sites ranged from 0% to 100%), followed by oncological use, at 25.3% (range 0% to 100%), musculoskeletal uses, at 18.7% (range 0% to 90%), and respiratory use, at 4.7% (range 0 to 19%). Details are available in Appendix D, Table 27. Due to the low response rate, data may not be representative of all sites, as suggested by the difference in cardiac use captured by this and the breakdown of use by cardiac, non-cardiac, and other uses.

Technical Characteristics of SPECT-CT Units

The number of CT multi-detectors (slices) was reported for 132 units, and the number of detector heads for 116 units. The number of slices ranged from one to 40, with the most common being four (31.8%), one (20.5%), and 16 slices (19.7%). A large majority of machines (94.8%) were equipped with two detector heads, and the remainder had one or three heads. Information on the field of view was gathered for 91 SPECT-CT units. The most common field of view was multi-purpose (94.5%), with the remaining five machines utilizing dedicated limited (1.1%), standard polyvalent (1.1%), and other (3.3%) views. Eighty-six units included responses for software for image processing. A third (32.6%, 28/86) of SPECT-CT units used dedicated limited software for image processing, with the remaining 67.4% using iterative reconstruction software. Out of 106 units that provided information on whether they were dedicated to cardiac imaging or used for multipurpose or non-cardiac imaging, a small minority — 7.5% (8/106) — were dedicated cardiac units, with the remaining 92.5% (98/106) used for multi-purpose or non-cardiac imaging. Finally, 95 units included information on whether the CT component of SPECT-CT units is operated as a stand-alone CT. Of these, 12.6% (12/95) of SPECT-CT do operate as stand-alone CT units, which allows for extra CT capacity in some facilities.

The survey also asked about features intended to manage radiation safety. Information on the number of machines equipped with dose management controls was available for 92 units, two-thirds (63.0%, 58/92) of which had these controls. Information on whether dose management controls were used was available for 46 units, of which 84.8% (39/46) use these controls. Data for the others were missing. Information was available for 79 units on whether they incorporated reconstruction techniques for dose reduction. Just more than half (55.7%, 44/79) incorporate reconstruction techniques for dose reduction. Information was available for 95 units on whether units recorded patient radiation dose per exam, and 61.1% (58/95) reported that they did.

Picture Archiving and Communication Systems (PACS)

Of the 251 sites (of 443 total) in 13 provinces or territories that reported PACS access, 33.2% have provincial/territorial access, 38.5% have regional access, and 28.3% have local access.

PACS images were widely accessible to referring physicians outside the imaging department, with access available at all sites with provincial/territorial or regional access and at 90.1% (64/71) of sites with local/institutional access. Access to PACS images throughout a provincial health care network, without the need to manually push images from any location or modality, was provided by 97.9% (94/96) of sites with provincial/territorial access, 63.9% (53/83) of sites with regional access, and 68.6% (48/70) of sites with local (institutional) access.

Some sites that lack a particular modality have access to images from that modality taken elsewhere. Table 18 shows the relationship between modality availability and PACS status for all sites and modalities with data available.

Table 17: Availability of Modalities and Images on PACS (Percentage of Sites) in 2017

Modality and PACS Status	CT	MRI	PET-CT	PET-MRI	SPECT	SPECT-CT
At site, on PACS	91.3	62.1	12.5	0	33.0	38.9
At site, not on PACS	1.2	4.7	2.3	0	13.8	10.6
Not at site, on PACS	1.2	4.7	3.7	50	5.4	3.0
Not at site, not on PACS	6.3	28.5	81.5	50	47.8	47.4

CT = computed tomography; MRI = magnetic resonance imaging, PACS = picture archiving and communication system; PET = positron emission tomography; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

Appropriateness of Orders Received

In response to a question about whether sites had a process for determining the appropriateness of received orders, 83.2% of 179 sites responded "yes," and 16.8% responded "no."

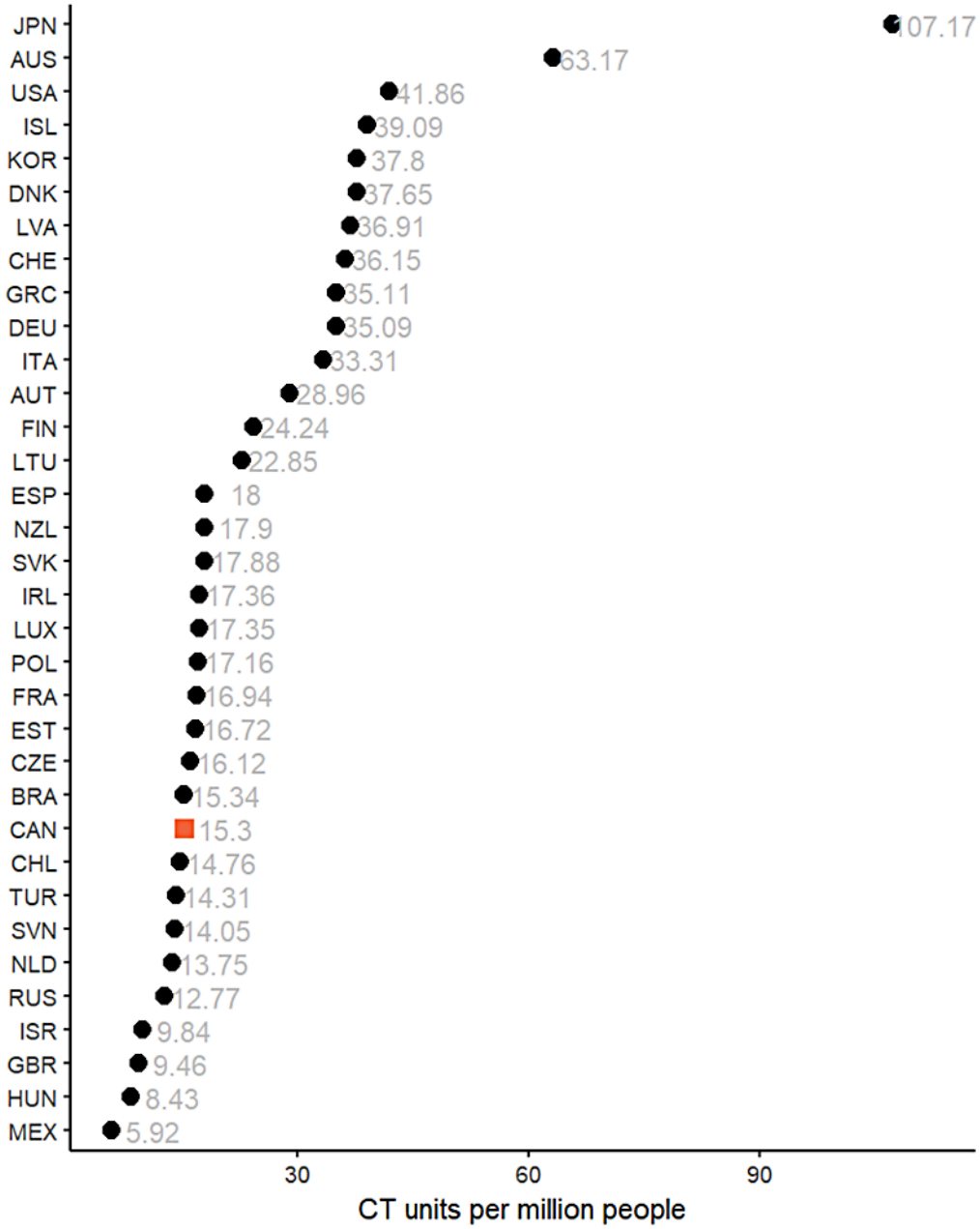
Canadian Data Versus International Data

The availability of unit count and use data allowed us to compare the Canadian data we collected with international data from the Organisation for Economic Co-operation and Development (OECD).[12-15] Last observation carried forward was used for all countries to impute values for comparison with the CMII 2017 data. Years of comparison were 2014 to 2016.

Computed Tomography

Based on the unit counts supplied by provincial validators, Canada appears in the lower third of OECD countries with data on number of CT units per million people collected by OECD,[15] a position similar to that in the last survey (Figure 10). Comparator data are the latest reported for each country, up to 2016.

Figure 10: Comparison of Canadian and International Data for CT — Total Units per Million People

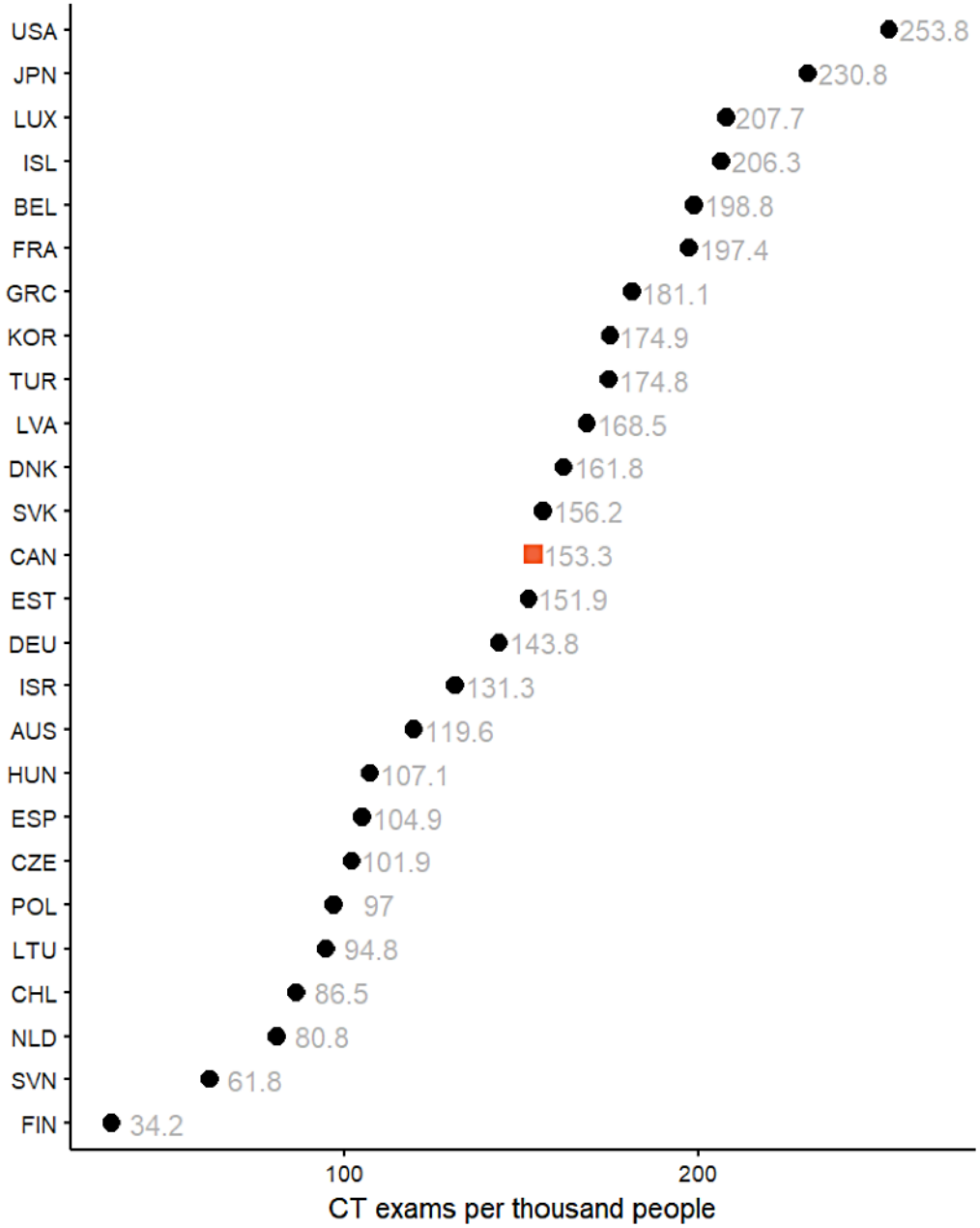


BRA = Brazil; AUS = Australia; AUT = Austria; CAN = Canada; CHE = Switzerland; CHL = Chile; CZE = Czech Republic; DEU = Germany; DNK = Denmark; ESP = Spain; EST = Estonia; FIN = Finland; FRA = France; GBR = Great Britain; GRC = Greece; HUN = Hungary; IRL = Ireland; ISL = Iceland; ISR = Israel; ITA = Italy; JPN = Japan; KOR = South Korea; LTU = Lithuania; LUX = Luxembourg; LVA = Latvia; MEX = Mexico; NLD = Netherlands; NZL = New Zealand; POL = Poland; RUS = Russia; SVK = Slovak Republic; SVN = Slovenia; TUR = Turkey.

Canadian data from CMII 2017 survey (red square) are compared with the latest data from each of the comparator countries, up to 2016.

Based on the exam totals for the most recent fiscal year provided by provincial validators, Canada appears in the middle third relative to the countries with data for CT exams collected by OECD,13 a position similar to that in 2015 (Figure 11). Examination data are for publicly funded sites only. Comparator data are the latest reported for each country, up to 2016.

Figure 11: Comparison of Canadian and International Data for CT: Total Exams per Thousand People



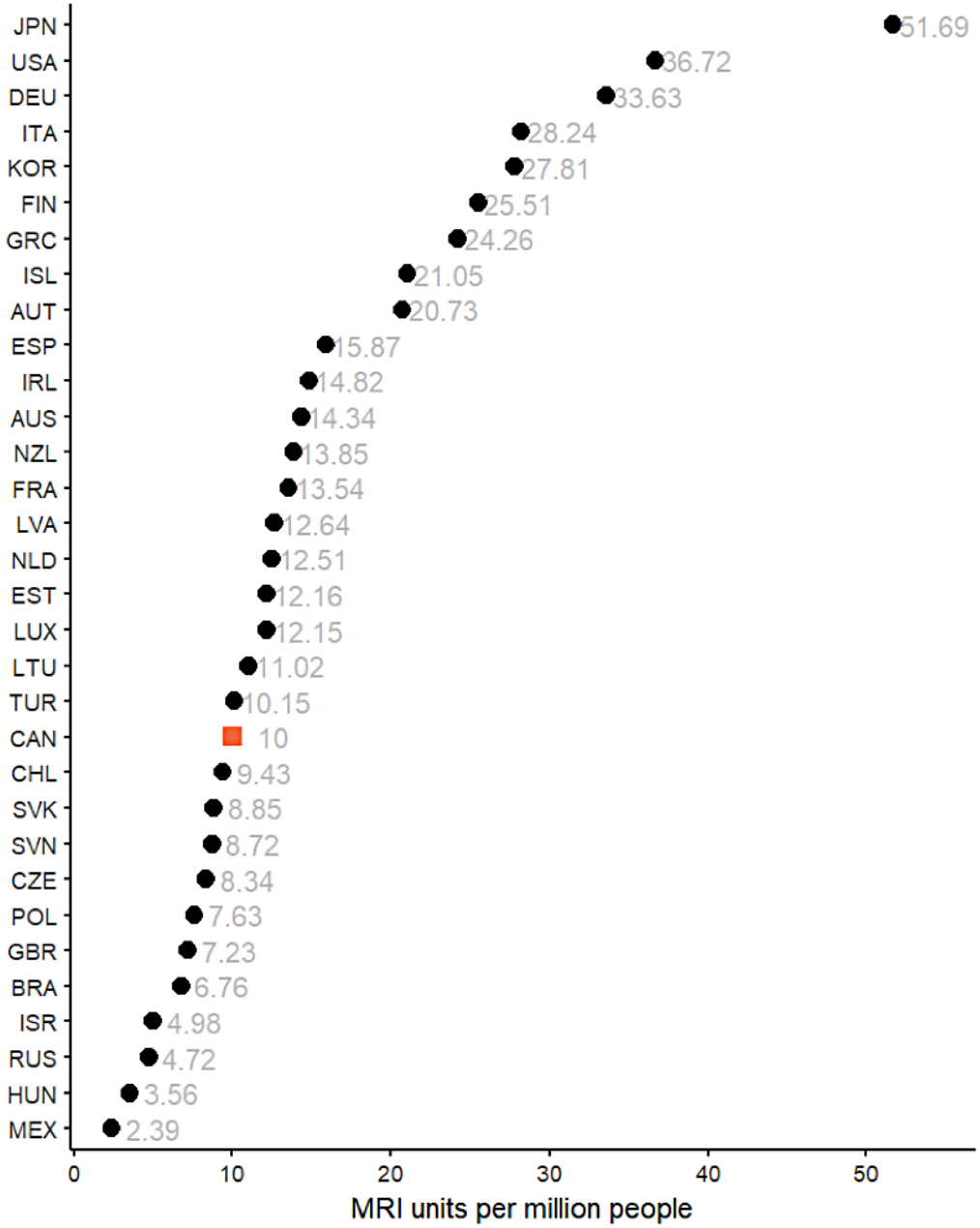
BRA = Brazil; AUS = Australia; AUT = Austria; CAN = Canada; CHE = Switzerland; CHL = Chile; CZE = Czech Republic; DEU = Germany; DNK = Denmark; ESP = Spain; EST = Estonia; FIN = Finland; FRA = France; GBR = Great Britain; GRC = Greece; HUN = Hungary; IRL = Ireland; ISL = Iceland; ISR = Israel; ITA = Italy; JPN = Japan; KOR = South Korea; LTU = Lithuania; LUX = Luxembourg; LVA = Latvia; MEX = Mexico; NLD = Netherlands; NZL = New Zealand; POL = Poland; RUS = Russia; SVK = Slovak Republic; SVN = Slovenia; TUR = Turkey.

Canadian data from CMII 2017 survey (red square) are compared with the latest data from each of the comparator countries, up to 2016.

Magnetic Resonance Imaging

Based on the unit counts supplied by provincial validators, Canada appears in the middle third of OECD countries with data for MRI units collected by OECD,[14] a similar position to 2015 (Figure 12). Comparator data are the latest reported for each country, up to 2016.

Figure 12: Comparison of Canadian and International Data for MRI: Total units per Million People

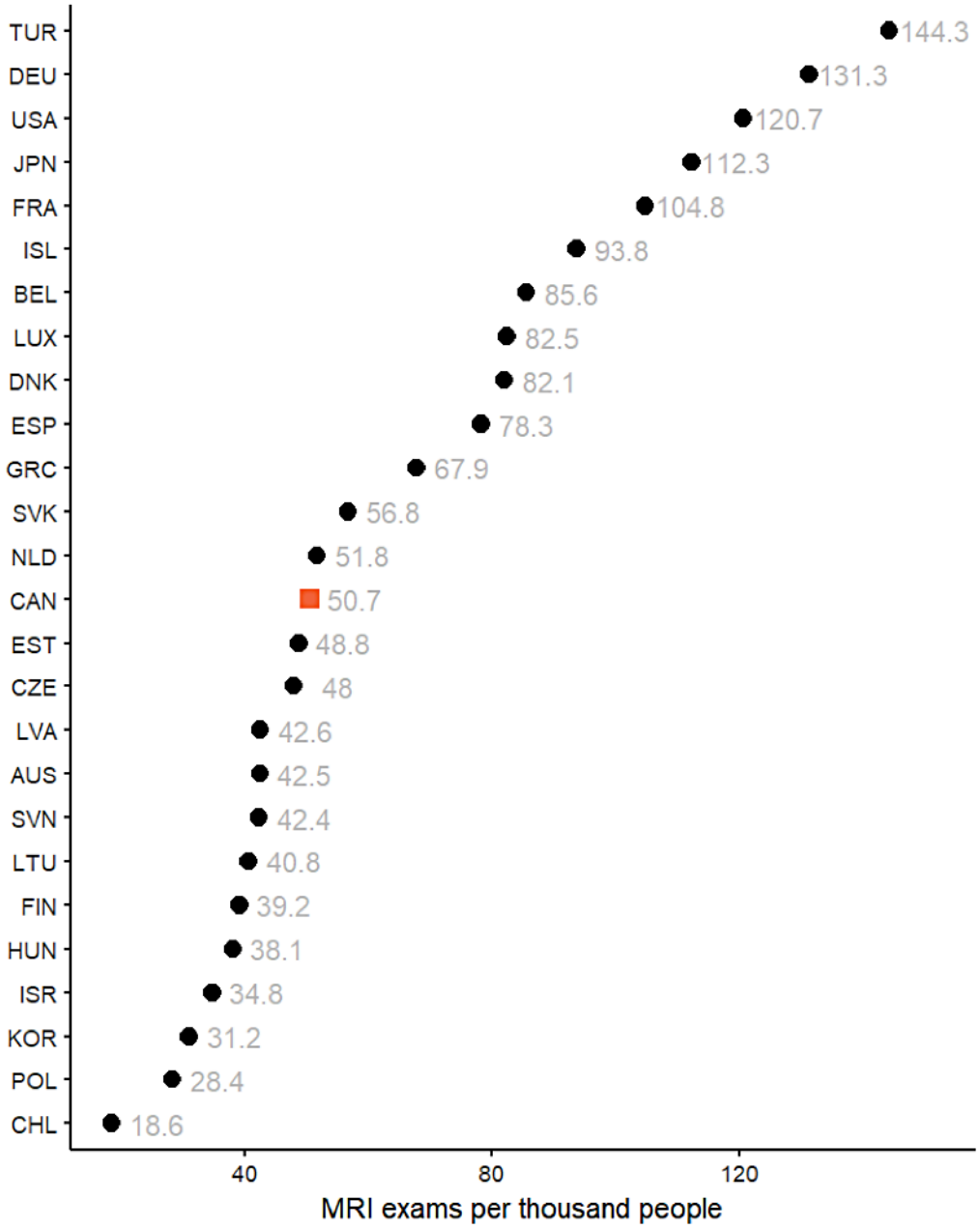


BRA = Brazil; AUS = Australia; AUT = Austria; CAN = Canada; CHE = Switzerland; CHL = Chile; CZE = Czech Republic; DEU = Germany; DNK = Denmark; ESP = Spain; EST = Estonia; FIN = Finland; FRA = France; GBR = Great Britain; GRC = Greece; HUN = Hungary; IRL = Ireland; ISL = Iceland; ISR = Israel; ITA = Italy; JPN = Japan; KOR = South Korea; LTU = Lithuania; LUX = Luxembourg; LVA = Latvia; MEX = Mexico; NLD = Netherlands; NZL = New Zealand; POL = Poland; RUS = Russia; SVK = Slovak Republic; SVN = Slovenia; TUR = Turkey.

Canadian data from CMII 2017 survey (red square) are compared with latest data from each of the comparator countries, up to 2016.

Based on the exam totals for the most recent fiscal year provided by provincial validators, Canada is in the lower half for MRI exams per thousand people relative to OECD countries with data for MRI exams collected by OECD,[12] a position similar to that in 2015 (Figure 12). Examination data are for publicly funded sites only.

Figure 13: Comparison of Canadian and International Data for MRI: Exams per Fiscal Year per 1,000 People



BRA = Brazil; AUS = Australia; AUT = Austria; CAN = Canada; CHE = Switzerland; CHL = Chile; CZE = Czech Republic; DEU = Germany; DNK = Denmark; ESP = Spain; EST = Estonia; FIN = Finland; FRA = France; GBR = Great Britain; GRC = Greece; HUN = Hungary; IRL = Ireland; ISL = Iceland; ISR = Israel; ITA = Italy; JPN = Japan; KOR = South Korea; LTU = Lithuania; LUX = Luxembourg; LVA = Latvia; MEX = Mexico; NLD = Netherlands; NZL = New Zealand; POL = Poland; RUS = Russia; SVK = Slovak Republic; SVN = Slovenia; TUR = Turkey.

Canadian data from CMII 2017 survey (red square) are compared with the latest data from each of the comparator countries, up to 2016.

Discussion

Overall Findings

These results are based on responses from a pan-Canadian survey of health care facilities, combined with historical data from previous surveys and data from provincial validators.

Type of Facility

Most sites that responded were publicly funded hospitals, community hospitals, or tertiary care centres in urban areas. The number of free-standing clinics varied across provinces, depending on policy and funding within the provinces. Some provinces use referral to free-standing clinics to manage wait times. Responding sites were predominantly urban, with just more than a quarter of the sites being rural, and a small number being remote. The setting data are incomplete, as sites that were identifiably remote did not have a response to that particular question. Some closely situated rural sites are served by mobile units (particularly CT or MRI) shared among several sites.

Modalities and Number of Units

Of the modalities surveyed, CT is the most widely distributed, with the highest number of units and highest volume of use overall (based on the number of exams and hours of use), followed by MRI. All provinces and territories have at least one CT unit; all provinces and Yukon have at least one MRI unit; and all provinces have at least one SPECT and SPECT-CT unit. None of the territories have SPECT or SPECT-CT. Nine provinces have PET-CT in clinical use. One province, Ontario, has PET-MRI.

Variation in Number of Exams and Hours of Use

For this iteration of the CMII, we reported validator data at the provincial level for the final summary, although we also collected site-level data on the number of exams and used these for imputation if validator data were unavailable. In some instances, there was a considerable difference between the data collected through the survey (whether imputation was conducted or not) and the data supplied by the validators. Data on hours per week, hours per day, and 24-hour or weekend use were collected by the survey. As in the 2015 survey, there was substantial variation in data collected from validators and from the survey in the number of exams, the hours of use (per week or day), and 24-hour or weekend use across and within jurisdictions. Some of this variation may be due to the availability of units, the availability of trained operators and clinicians, and the age of units. Regional variations in practice, guidelines, adherence to guidelines, and data collection may also play a role.

Variation in Type of Use Across Modalities

As in the previous iteration, we collected data on the distribution of use among cardiac, non-cardiac, research, and other categories of use. In addition, for this iteration, we collected more detailed data on distribution of use by clinical discipline. All modalities were used predominantly for non-cardiac purposes, although SPECT and SPECT-CT have higher cardiac use. Among disciplines, oncology, musculoskeletal imaging, and neurology form the major uses for all modalities, with the exception of PET-CT, which is almost entirely used for oncology with a small proportion of neurology imaging. Cancer, injuries, degenerative musculoskeletal disease, and neurological injury and disease are all common conditions.

PET-MRI is at present used for research purposes only.

Again, we focused on reporting imaging for clinical purposes in our selection of survey contacts, so imaging for research purposes may be underreported. In large centres, research facilities for medical imaging may be separate for clinical (diagnostic or interventional) imaging, and the survey and validation may not have captured all units primarily used for research. Other uses may have been captured but not identified under the "other" category, such as animal research studies or veterinary imaging, although the percentage under the "other" category was small.

Age of Diagnostic Imaging Equipment

Using the information presented in Table 6, direct comparisons between the age of equipment in Canada and the age of imaging equipment guidelines published by the Canadian Association of Radiologists (CAR)[19] and the European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry (COCIR)[20] can be made.

The CAR guidelines[19] propose life expectancies for imaging equipment according to use, which can be classified as either high, medium, or low, based on the number of examinations per year. For the five modalities with age information from the CMII (CT, MRI, PET-CT, SPECT, and SPECT-CT) the CAR guidelines propose life expectancies of eight, 10, and 12 years for high, medium, and low usage machines, respectively. When CMII data are compared with the CAR life expectancies for medium-use machines (as an example), 25.7% of CTs, 30.0% of MRIs, 15.8% of PET-CTs, 57.5% of SPECTs, and 12.4% of SPECT-CTs are 11 years of age or older (as determined by the survey), whereas the CAR guideline recommends a device life expectancy of 10 years for the medium-use range. The CAR guidelines also recommend that the maximum life expectancy and clinical relevance for any imaging equipment should not be expected to exceed 15 years. The age of PET-CT, the newest modality in clinical use, is consistent with this recommendation, suggesting that the transition from PET to PET-CT is complete. Two per cent (2.4%) of CT units, 3.5% of MRI units, and 0.5% SPECT-CT units are older than 15 years, and a substantial percentage (21.4%) of SPECT units are beyond the CAR's recommended life expectancy. Trends over time suggest that SPECT units are progressively being upgraded to or replaced by SPECT-CT units.[8,10,11,21] The maturity and stability of the technology and the lack of incentives for or barriers to upgrading may be factors in prolonging operation of SPECT units.

The COCIR guidelines[20] contain three "Golden Rules" created to evaluate medical equipment age and aid procurement decisions, creating an age profile that aims to balance keeping equipment current with the need to maintain efficient health care systems:

- At least 60% of imaging equipment should be five years old or less. None of the imaging modalities meet this criterion, with 34.0% of CT units, 36.4% of MRI units, 31.6% of PET-CT units, 12.9% of SPECT units, and 39.5% of SPECT-CT units being five years of age or newer.
- No more than 30% of imaging equipment should be between six and 10 years old. Only SPECT meets this criterion, and, as previously described, SPECT machines are older. Overall, 40.3% of CT units, 33.5% of MRI units, 52.6% of PET-CT units, 29.6% of SPECT units, and 48.1% of SPECT-CT units are between the ages of six and 10.
- No more than 10% of imaging equipment should be older than 10 years. None of the modalities meet this criterion, with 25.7% of CT units, 30.1% of MRI units, 15.7% of PET-CT units, 57.5% SPECT units, and 12.4% of SPECT-CT units older than 10 years.

The CAR is a professional medical association with industry partnerships based in Canada, so its recommendations are more cognizant of Canadian practice and the health care landscape. The COCIR is a European-based organization representing the manufacturers of diagnostic imaging equipment, and therefore may be less relevant to the Canadian context. Overall, imaging equipment in Canada appears to trend older than the recommended profile, but, as the CAR guidelines indicate, lifetime depends on extent of use. We do not currently have unit-level exam data, having requested average exams for all units at a site. In addition, the number of exams is unavailable for many sites.

PACS Accessibility

Most facilities with units for modalities at a site also stored PACS images for those modalities, while a minority of sites without units available had access to PACS images for those modalities. We do not know what forms of storage are used at sites where PACS is not used, and how the images are shared with referring physicians and consultants.

Jurisdictional Differences

The Influence of Geography

The survey was restricted to the six advanced medical imaging modalities identified by experts as of the most interest, and these modalities are concentrated in major urban centres and in provinces and territories with larger populations. The larger provinces — Alberta, British Columbia, Ontario, and Quebec — have the greatest variety of modalities and number of individual units, followed by Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, and Saskatchewan, which have a relatively modest number of units. Jurisdictions with the fewest units include the territories and Prince Edward Island.

The number of units per million people is more consistent across provinces than the total unit counts per population, but this measure does not account for population distribution in the respective provinces or territories. As an example of the geographic challenges, the Northwest Territories and Nunavut each have a single CT unit serving the entire region (22.53 and 26.69 units per million population, respectively). Quebec, a province of comparable area, has 163 units (19.47 units per million population), predominantly in the south of the province.

Some of the smaller and less populated provinces or territories lack within-jurisdiction access to most modalities, and access may depend on cross-jurisdictional partnerships, patients' abilities and willingness to travel, and integrated telemedicine services.

Funding Structures

One aspect of medical imaging practice that the survey did not address was potential differences in funding structures across jurisdictions, specifically private–public partnerships[22,23] and cost-sharing across jurisdictions (e.g., Ontario/Manitoba).[24] Based on comments provided by survey respondents, there may be cross-jurisdictional care of patients, as well as referral of wait-listed patients to private clinics. In both of these scenarios, it is not clear whether private or public funds are used to cover the costs of imaging and care. Regulatory frameworks in place to govern operation of private facilities may also differ across jurisdictions[25] and may influence the type of imaging modality and the number and utilization of private clinics.

Trained Personnel

The availability of trained personnel to conduct and interpret imaging exams may also contribute to some of the variation observed across sites. An academic training centre,

research facilities, and large health care facilities that provide employment opportunities may be necessary to attract clinicians, technologists, technicians, and other support staff (e.g., radiation safety specialists and nuclear medicine physicists). Remote or rural centres may face challenges in attracting and retaining highly trained professionals, or in providing training and continuing education for existing staff.[26] As telemedicine and mobile technologies evolve, there may be opportunities to provide improved access through the combination of these innovations.

Impact of Availability on Wait Times

Wait times for medical imaging are an ongoing concern in Canada.[27] While provincial strategies are in place to reduce wait times for these services, Canadian patients are still waiting beyond targeted wait times.[28,29] Overall, wait times have increased for CT and MRI (the only modalities for which wait times are recorded and that are relevant to this report) over the last five years. The CAR recommends maximum MRI and CT wait time targets of 24 hours for emergency/life-threatening conditions, seven days for urgent conditions, 30 days for semi-urgent conditions, and 60 days for non-urgent conditions.[27] Median wait times for medically necessary elective MRI are longer (10.8 weeks) than for CT (4.1 weeks), and there is variation across jurisdictions, with half of patients receiving an MRI exam within 33 to 84 days and receiving a CT within six to 34 days.[28,29] While wait times have increased, so have the number of exams performed by radiology professionals, with a 75% increase in CT exams and a 82% increase in MRI exams over the last decade. Our findings indicate that imaging machines are used for an average of eight to 13.3 hours per day for CT and nine to 16.2 hours per day for MRI, suggesting there is capacity to do more exams on existing equipment, rather than invest in new equipment, which is a common strategy used to reduce wait times.[30] This will not, however, improve access in regions where there is no existing imaging equipment, or address restrictions due to funding of imaging and availability of radiologists, technicians, and support staff.

Trends Over Time

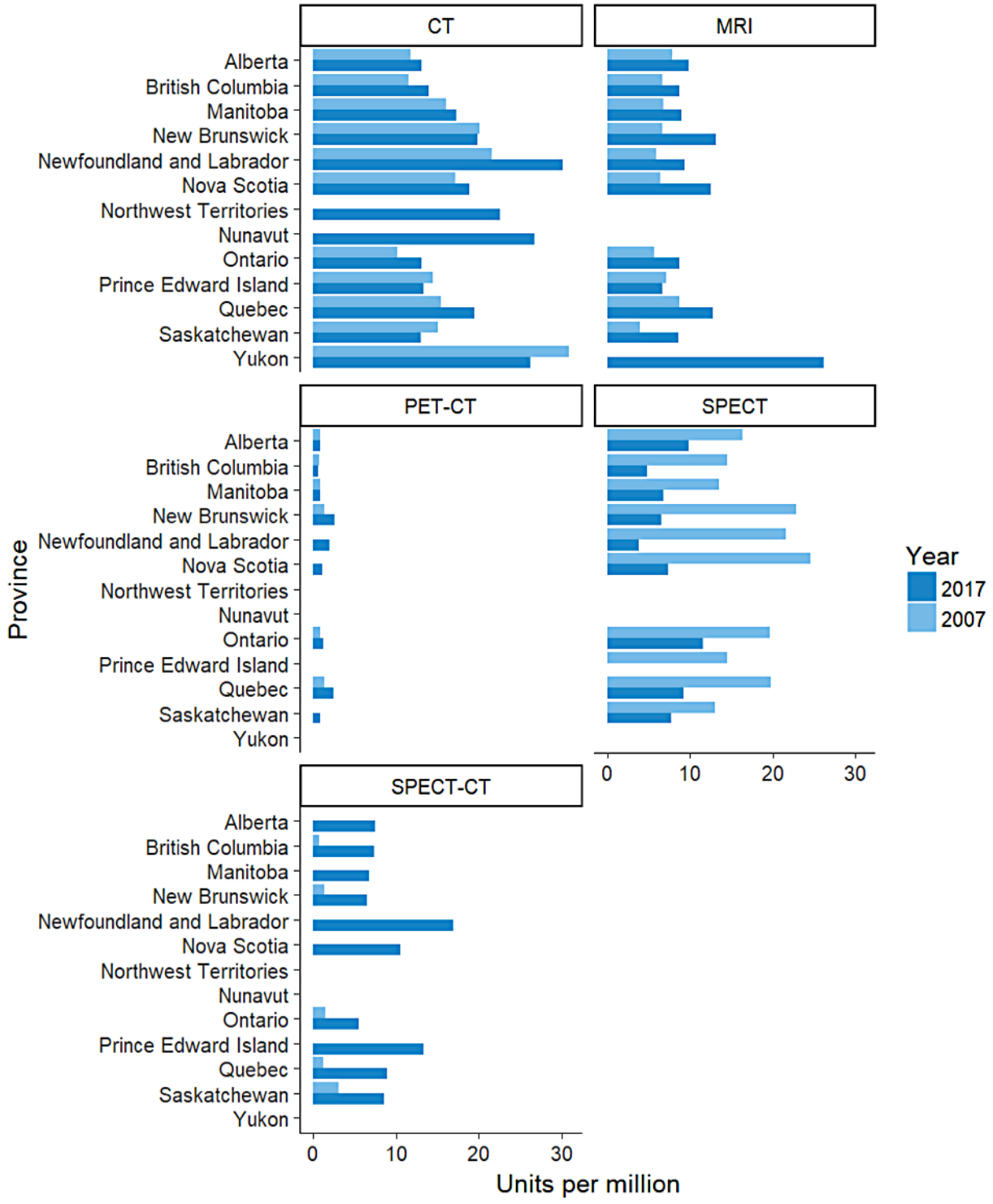
Overall Summary

Each imaging modality, with the exception of SPECT, experienced growth over the last 10 years in Canada, both in numbers of units and in number of units per million people (Figure 14). The 2017 figures are drawn from this report, and the 2007 figures, from a report by CIHI published in 2007.[11] The most rapid growth occurred with the hybrid modality SPECT-CT, followed by PET-CT and MRI. The most widely available imaging modality in Canada and the only imaging modality that is available in all provinces and territories (CT) experienced the slowest growth rate of all imaging modalities, at 35% over the last decade. This slow growth rate, compared with other imaging modalities, may be related to that fact that the CT market may already be saturated in Canada. Based on the available data in the 2017 CMII, 53% of CT units installed in the last five years were replacements, compared with 17% of MRI units.

In 2006-2007, SPECT was the most popular imaging modality, with 603 units in 10 jurisdictions.[10] In 2016-2017, the number of SPECT units declined to 330 in nine jurisdictions. The decline of 45% may be connected to the rapid adoption of SPECT-CT. For each modality, approximately 60% of all growth can be attributed to two provinces, Quebec and Ontario. PET-MRI had yet to emerge.

Examination data for 2006-2007 were reported only for CT and MRI. The number of exams increased by 75% and 82% for the two modalities, respectively, and the number of exams per thousand population increased by 48% and 63%, respectively.

Figure 14: Change in units per population between 2007 and 2017 for CT, MRI, PET-CT, SPECT, and SPECT-CT



Computed Tomography

CT is the only imaging modality reviewed in this report that is available in every jurisdiction (province or territory). There were 419 CT units in Canada in 2006-2007,[10] compared with 561 in 2016-2017, representing a 34% increase over the last 10 years. There was at least one CT unit, to a maximum of 184 CT units, per jurisdiction in 2016-2017, compared with 10 years ago, when 12 jurisdictions had between one and 130 CT units each. For both 2007[10] and 2017, 60% of all CT units were located in the two most densely populated provinces, Ontario and Quebec.

Over the last 10 years, growth in CT units outstripped population growth, with the greatest increase in Newfoundland and Labrador (21.6 units per million[10] to 30.2 units per million) and Quebec (15.5 units per million[10] to 19.5 units per million). CT units per million people decreased for five jurisdictions, as the number of CT units remained unchanged while the population grew. For all of Canada, CT units per million people expanded from 12.8 per million people in 2006-2007[10] to 15.4 CT per million people in 2016-2017.

There were 3,380,597 publicly funded CT exams in Canada in 2006-2007,[10] compared with 5,611,107 in 2016-2017, representing a 75% increase over a decade. Six jurisdictions (British Columbia, Ontario, Quebec, Prince Edward Island, Yukon, and the Northwest Territories) experienced a growth rate of 60% or more in the number of exams. Nationwide, the overall rate of CT examinations per 1,000 population increased from 103.3 to 153, representing a 48% increase over the last 10 years.

Magnetic Resonance Imaging

Of the imaging modalities reviewed in this report, MRI is the second most numerous. There were 222 MRI units in 10 jurisdictions in 2006-2007[10] compared with 366 in 11 jurisdictions in 2016-2017, representing a 65% increase over the last 10 years. The two jurisdictions with no existing MRI capacity also have the lowest populations in Canada. Approximately 60% of all MRI units are located in Ontario and Quebec, and this was the same in 2006-2007.

The number of MRI units per million people increased for all jurisdictions with existing MRI capacity over the last 10 years, with the exception of Prince Edward Island, where the number of units remained unchanged although the population experienced 9% growth. The jurisdictions with the greatest growth in MRI units per million — New Brunswick, Nova Scotia, and Saskatchewan — doubled their MRI capacity over the 10-year period. For all of Canada, MRI units increased from 6.8 per million people in 2006-2007[10] to 10.0 MRIs per million people in 2016-2017.

In 2016-2017, the number of MRI exams conducted in Canada was higher in all jurisdictions compared with 2006-2007. Around 1 million MRI exams were conducted in Canada in 2006-2007,[10] compared with 1,855,110 in 2016-2017, representing a 82% increase over 10 years. In 2016-2017, Ontario accounted for 47% of all MRI exams, compared with 44% of all MRI exams in 2006-2007. For Canada as a whole, the rate of MRI examinations per 1,000 population rose from 31.2[10] to 51.0, an increase of 63%.

Positron Emission Tomography and Positron Emission Tomography–Computed Tomography

There were 21 PET-CT in Canada in 2006-2007,[10] compared with 51 in 2016-2017, representing a 65% increase over the last 10 years. There were PET-CT units in nine jurisdictions in 2016-2017, compared with six jurisdictions 10 years ago.[10] The jurisdictions

with no PET-CT are the jurisdictions with the smallest populations. About 74% of all PET-CT units were in Ontario and Quebec in 2006-2007, and there is no notable change in 2016-2017.

At the national level, PET-CT units increased from 0.9 per million people in 2006-2007[10] to 1.4 per million people in 2016-2017. Seven jurisdictions experienced a slight growth in the number of PET-CT per million people over the last 10 years. One jurisdiction experienced a slight decline in units per million population.

Single-Photon Emission Computed Tomography

SPECT is the only imaging modality reviewed in this report that decreased in numbers over the last 10 years. In 2006-2007, SPECT was the most commonly available imaging modality in Canada, with 603 units in 10 jurisdictions.[10] Ten years later, there were 330 SPECT units in nine jurisdictions, representing an overall decline of 45%. The number of SPECT units may be lower than reported because some jurisdictions include planar imaging in this count.

For all of Canada, SPECT declined over the last 10 years, from 18.4 per million people in 2006-2007,[10] to 9.0 per million people in 2016-2017. The decline is SPECT may be attributed to its gradual replacement by SPECT-CT. In 2006-2007, Ontario and Quebec accounted for 67% of all SPECT, compared with 71% in 2016-2017.

Single-Photon Emission Computed Tomography–Computed Tomography

SPECT-CT is unique among the imaging modalities reviewed in this report, in that it experienced significant rapid growth over the last 10 years compared with the other modalities. In 2006-2007, there were 35 SPECT-CT units in five jurisdictions,[10] compared with 261 SPECT-CT units in 10 jurisdictions in 2016-2017, representing an increase of 646% over the last decade. Ontario and Quebec account for 58% of all SPECT-CT in 2016-2017, compared with 80% in 2006-2007.

Correspondingly, SPECT-CT units increased from 1.0 per million people in 2006-2007[10] to 7.3 per million in 2016-2017.

Appropriate Imaging and Radiation Safety

There is growing concern about potential health hazards associated with imaging exams that use radiation.[31] Most of the emphasis is placed on CT exams because CT accounts for the majority of total radiation received by patients from any imaging modalities,[31] although hybrid imaging modalities that use CT are also significant contributors to individual patient radiation dose.[32] Our survey indicates that 80% of facilities have a process in place for determining the appropriateness of imaging exams. As well, dose-management controls and unit recording of patient radiation dose per exam are widely used for CT, PET-CT, and SPECT-CT. A CADTH pan-Canadian survey of awareness and implementation of the 10 priorities of the Bonn Call for Action[33] on radiation protection indicated a commitment to improving radiation safety, with most respondents reporting at least partial implementation (with intent toward further implementation) at their institutions and in Canadian clinical practice.[34]

Canadian Data Versus International Data

Compared with other countries of varying levels of development around the world, as recorded by the OECD, Canada currently appears in the lower third of countries reporting the

number of CT units per population to the OECD, slightly down in ranking from 2015. Canada ranks around the middle for MRI units. Canada appears in the upper 50% for number of CT exams per population and in the lower 50% for MRI exams.

Our estimated number of exams is based on validator-supplied data, which included only publicly funded facilities, potentially leading to undercounting for the jurisdictions with private facilities.

No OECD data were publicly available on the other modalities of interest, and so Canada's status compared with other countries is unclear in these cases. In the future, it would be interesting to compare Canada's adoption of emerging technologies (e.g., PET-MRI) against other countries, especially as adoption and clinical use increases.

Strengths

The data collected for this report are part of an ongoing survey of medical imaging equipment in Canada that was first reported in 2001.[11] As such, this survey meets a need that is especially relevant in the current environment of proliferating use of medical imaging and emergent technologies and clinical applications.

The data have been compiled through several iterations of surveys, augmented by information on installations from three of the major suppliers of imaging equipment in Canada. Extensive efforts have been made to obtain high-level data from provincial and territorial validators. Through these efforts, we believe an accurate characterization of the medical imaging landscape in Canada has been achieved. This version of the survey also reports data on technical specifications and age of imaging units in Canada, and trends over time, allowing further insight of associations with patterns of use not only by modality, but also by specific type of modality.

Limitations

Selection of Imaging Modalities

For reasons of feasibility, this iteration of the survey was restricted to six specialist imaging modalities, and omits others that are more common and widespread (for example, X-ray and ultrasound) or that were included in earlier years of the survey (planar gamma cameras, angiography, and bone densitometry). This focus biases the coverage toward urban areas, and does not capture alternative imaging options available outside these regions, especially in remote or rural areas, where patients need to travel or be transferred significant distances for imaging. In addition, these exclusions may limit understanding of the relationship among modalities within the health care system (for example, in pathways that involve multiple modalities), and may limit consideration of funding allocation for diagnostic imaging across all modalities. We will review inclusion of additional modalities for future iterations of the survey as needs and technologies evolve, and we will consider the possibility of conducting a survey limited by geography (i.e., focused on remote areas) rather than by modality.

Private Versus Public Coverage

As participation in the survey was not mandatory, and a definitive up-to-date list of facilities using medical imaging equipment in Canada was lacking, we cannot ensure that all facilities were contacted or represented. In particular, there was a notable difference in the representation of public and privately funded facilities, with more responses from the former. Publicly funded facilities were more readily identified than private facilities, as their data tend to be held at multiple

administrative levels. Most provinces lack a publicly available repository of private imaging facilities. This may lead to underestimation of the number of units and of the total number of exams, particularly in jurisdictions where privately run imaging contributes to the overall use.

Variable Instrument Coverage

The quality and completeness of the data collected appear to be relatively high for CT and MRI compared with the other modalities. Both modalities are well-established and have seen longstanding use. For SPECT and SPECT-CT, data are more variable; for instance, one province (Ontario) reported combined SPECT and SPECT-CT counts, and several provinces reported combined SPECT and SPECT-CT exams, or reported a single total for nuclear medicine exams as a whole. It is possible that, in facilities with both a diagnostic imaging and a nuclear medicine department, that we failed to reach the latter. With repeated iterations of the survey, we expect to extend our lists of contacts and obtain more specific information.

Reliability

The accuracy of the data in this report is in part reliant on the personal knowledge of survey participants of their particular health care setting. Level of insight and accuracy of estimates may vary substantially and contribute to variability in the quality and completeness of reporting. Recall bias cannot be avoided, as we were unable to assess whether all information was visually verified and based on real data, or whether questions were answered from memory. Further, respondent fatigue may have affected the responses for difficult questions, such as those regarding the number of examinations or hours of use, particularly if real-time data were not recorded at the facilities.

Industry data came in the form of technical extracts, and contained not only original installations but upgrades, which were on occasion difficult to distinguish. Entries contained abbreviations and industry-specific labelling, which had to be interpreted by the researchers entering the data, with the possibility of misinterpretation, especially misidentifying an upgrade as a new installation. This would not affect overall counts, which were supplied by validators, but might introduce errors into the summaries of technical specifications and age, although these are expected to be minor. We hope to explore the impact of equipment upgrades in future cycles.

Inconsistency in Data Sources

The data uploaded to the survey before opening it for responses were derived from several sources: unit technical specifications from the CMII 2012 data set, facility and technical responses from the 2015 CMII survey, and technical specifications supplied by industry contacts. Several rounds of data reconciliation were required to assemble the data set and remove duplicate entries. Facility names required standardization to identify variations in names and trace name changes and restructuring. Units had to be matched across data sets using available data to avoid duplication, with interpretation of abbreviations and industry-specific terminology. Dates were variously reported as year of installation or first year of operation, and frequently varied across data sets, leading to a one- or two-year uncertainty in the age of individual units, and possibly a corresponding uncertainty in the averages (depending on whether all the errors were in the same direction).

Sites varied in whether they considered certain units to be SPECT or SPECT-CT. Validator reporting of SPECT and SPECT-CT examinations was particularly variable, with combined

reporting of SPECT and SPECT-CT exams for four provinces, preventing calculation of the exams for individual modalities, including other nuclear medicine modalities in the totals for two, inflating the results, and reporting only partial information for one province.

Effect of Missing Responses, Assumptions, and Imputations

The technical data for individual units were collected by CIHI for units installed before 2012, and by CADTH for units installed after 2012. This compilation included older units that had not been identified as having been decommissioned. Sites were asked to identify whether individual units had been decommissioned, but, as not all sites reviewed and updated their data, not all decommissioned units were identified. When counts were reconciled with validator data, the oldest surplus units of each modality were assumed to have been decommissioned at each site. If this assumption were incorrect, this would affect the summaries of ages and technical specifications.

Use data (e.g., hours per day and per week) were not updated for all sites. The assumption was made that use data were unlikely to have changed for most sites, and hours per day, hours per week, and types of use were carried forward from 2015 when unavailable for 2017. The data for the new questions around use by discipline were relatively sparse, and we do not know whether the responding sites were representative of all sites.

Variable Interpretation of Questions

Based on comparisons of weekly and daily hours, there was variation in whether sites averaged hours over all calendar days, or only days of operation. If the former, the hours of operation would be underestimated. The question on whether modalities operated on a 24-hour basis did not differentiate between scheduled and on-call availability. Comparison of the data for hours per day with the data for 24-hour operation, and the data for hours per week with the data for weekend operation, suggested that sites varied in their definition of operation (some reported too few hours to have had 24 hours of staffed operation). Therefore, the overall hours of potential availability might be underestimated, and the hours of operation overestimated.

Future Directions and Next Steps

Future Directions for the CMII

Further aspects to explore related to the conduct of the inventory include the following:

- How should we capture hardware upgrades to existing installations, which several respondents have remarked upon (in comments on the survey) and which have the potential to extend the usable lifespan of equipment substantially?
- How might we capture the impact of software upgrades on the currency of imaging equipment?
- How might we capture the eventual impact of artificial intelligence/machine learning/deep learning in terms of use of current equipment and requirements for adjunct equipment?
- How should we extend capture of availability and use for privately funded sites, which in some jurisdictions contribute significantly to overall imaging use?
- How should we determine whether the age profile of current units is appropriate to their level of use, as the data were not available to categorize levels of use and compare with age, as described by the CAR?
- How should we capture the installation of previously used equipment?

Policy, Research, and Clinical Practice Questions

Other questions have been provoked by developments in diagnostic imaging, health technology assessment, and the current medical imaging context in Canada:

- How might tracking of equipment through the entire life cycle enable planning for the replacement of equipment, through entire life cycle
- The inventory of equipment might assist in planning the implementation of other therapies that depend on imaging (e.g., proton beam therapy requires a CT, MRI, and PET/CT scanner, and the inventory can identify where these already exist).
- How can the health care system improve access to imaging for patients in remote and rural areas?
- How does practice in remote and rural areas adapt to the lack of ready access to specialized diagnostic imaging?
- What is the cost-effectiveness of medical imaging technologies (taking into account wait times, clinical pathways, and clinical utility)?
- What is the regulatory framework in place to support private–public partnerships, specifically in terms of eligibility for private imaging (e.g., length of wait-list) and proportion of public funding provided?
- How does legislation regarding diagnostic imaging differ across jurisdictions, and does that influence the way devices are distributed and used?

Conclusions and Implications of Findings

This report presents data on the number of units, their distribution, and their volume and type of use across Canada for six medical imaging modalities, as informed through a comprehensive survey and data-collection process, building on previous iterations of the survey by CADTH and others.[35-37] It discusses changes over time, the age of units, technical characteristics, and Canada's status compared with other countries.

The survey results provide insight into the current context of medical imaging across Canada. They raise relevant questions related to how medical imaging is monitored and regulated, and how it is optimally used. As well, they raise questions about how funding structures are organized, what the most cost-effective practices are, as well as whether access is equitable, especially in rural and remote areas. Overall, the findings of this report may help decision-makers identify gaps in service; inform medical imaging–related strategic planning on a national, provincial, or territorial basis; and help anticipate future growth and need for replacement. CADTH plans to explore the possibility of investigating some of these issues in future knowledge-synthesis work.

Data for the next iteration of the survey is planned to be collected in the summer and fall of 2019, and the update will be published in 2020.

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Appendix A: Introduction to Imaging Modalities for Which Data Were Collected in the 2017 Imaging Inventory

Computed Tomography

Computed tomography (CT) employs X-rays as a source of ionizing radiation, sensitive radiation detectors, and computerized analysis to create cross-sectional images of the body, including the head, heart, lungs, cardiovascular system, musculoskeletal system, abdomen, pelvis, and spine.[38] Specialties that routinely employ CT include neurology, cardiology, oncology, internal medicine, orthopedics, and emergency trauma care.

The main advantages of CT are its speed, which enables rapid imaging and diagnosis in urgent situations, and its ability to visualize fine details in bone, lungs, and other organs.[38] CT involves exposure to ionizing radiation, which means that the risk–benefit of its use in pregnancy and in young children, and its repeated use, must be assessed.[38-40]

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) uses powerful electromagnetic and radiofrequency fields and computation to produce cross-sectional images of the body, including the head, neck, cardiovascular system, breast, abdomen, pelvis, musculoskeletal system, and spine.[41] Specialties that commonly employ MRI include neurology, gastroenterology, cardiology, oncology, internal medicine, orthopedics, and emergency services.[41]

MRI does not use ionizing radiation, and therefore may be preferred if CT and MRI would provide comparable information, for example when imaging children.[41] MRI provides high sensitivity and soft tissue details, especially in the abdomen and pelvis, allowing for visualization of anatomy and pathologies. In oncology, this assists in early diagnosis, staging and re-staging, assessment of treatment response, and detection of recurrence in various types of cancer.[41]

A disadvantage of MRI is that the exams can take up to an hour or more, and patients must be able to remain motionless within a narrow enclosure. It may not be suitable for patients with claustrophobia, those who cannot lie flat for prolonged periods, or those who are obese.[41-43] The magnetic fields and radiofrequencies used in MRI are incompatible with many common implantable medical devices, such as deep brain stimulators, cochlear implants, and pacemakers.[43,44] All patients undergoing an MRI exam must be screened beforehand to identify any potentially contraindicated devices or metallic foreign bodies.[43,44]

Nuclear Medicine

Single-Photon Emission Computed Tomography

In nuclear medicine imaging, trace amounts of radiopharmaceuticals are administered to patients intravenously or by injection (e.g., subcutaneously or intradermal), ingestion, or inhalation to visualize areas of radioisotope uptake within the body. Depending on the radiopharmaceutical administered, the function (i.e., physiology) of almost any organ system can be observed.[45] Nuclear medicine gamma cameras detect the gamma rays emanating from the radioisotope and form flat images; most cameras are also capable of cross-sectional imaging (single-photon emission computed tomography, SPECT).

Nuclear medicine exams identify and evaluate a variety of pathologies, including cancer, heart disease, and gastrointestinal, endocrine, and neurological disorders. Medical specialties that commonly use SPECT imaging include oncology, neurology, cardiology, internal medicine, orthopedics, pediatrics, pneumology, and infectious disease.

Positron Emission Tomography

Positron emission tomography (PET) uses injection of a sugar or other metabolic tracer labelled with a positron-emitting radioisotope, sensitive radiation detector cameras, and powerful computers to detect and visualize areas of increased metabolism, such as tumours. It creates three-dimensional images of regions of interest such as brain, bone, and heart.[46]

The main advantage of PET (or its successor, positron emission tomography–computed tomography, PET-CT) imaging is the ability to precisely quantify metabolic processes (e.g., the rate of glucose metabolism) and, depending on the pathology, to more accurately localize abnormalities. PET radiolabelled sugar (i.e., fluorodeoxyglucose [^{18}F–FDG]) is the most common PET tracer currently used in Canada, but other tracers are becoming available, especially for cardiac and neurological imaging. Another advantage of PET-CT imaging is that the whole body can be imaged, which is useful for assessing tumour spread or recurrence.

Medical specialties that commonly use PET imaging include oncology, neurology, psychiatry, cardiology, pediatrics, and infectious disease.

Disadvantages of Nuclear Imaging Modalities

SPECT exams may involve scanning over hours to days (at intervals), although the duration of the imaging may be similar to an MRI. Nuclear medicine also involves exposure to ionizing radiation, which means that the risk–benefit of its use in pregnancy and young children, and its repeated use, must be carefully assessed. Nuclear medicine scans have lower resolution than other imaging modalities.

The cost associated with obtaining and transporting medical radioisotopes is an ongoing concern.[45]

Hybrid Medical Imaging Technologies

Hybrid imaging combines two or more imaging modalities to take advantage of the characteristics of each. Therefore, hybrid imaging can simultaneously provide high anatomic detail and metabolic and/or physiological function, enabling more accurate diagnosis, better care pathways, refined treatment regimes, and improved patient outcomes.[45]

Single-Photon Emission Computed Tomography–Computed Tomography

Single-photon emission computed tomography–computed tomography (SPECT-CT) combines SPECT and CT to create three-dimensional images of the body part of interest, such as brain, bone, and heart. Its main advantage is that it offers both metabolic and physiologic information, coupled with the resolution of CT. During a hybrid SPECT-CT, both scans are performed in sequence; the images are then computationally aligned with each other to show anatomic and functional detail, and to enable attenuation correction of the SPECT signal. Medical specialties that commonly use SPECT-CT imaging include oncology, neurology, cardiology, internal medicine, and orthopedics.

The disadvantages of SPECT-CT are those of the component modalities, both of which involve exposure to ionizing radiation,[47] and concerns about availability of radioisotopes.

Positron Emission Tomography–Computed Tomography

Positron emission tomography–computed tomography (PET-CT) combines the modalities of PET and CT, creating three-dimensional images of the body part of interest, such as brain, bone, and lung. Both scans are performed in sequence during a single session, and the images are computationally aligned.[48] PET-CT is commonly used in oncology to diagnose and stage various types of cancers, such as lung, gastrointestinal, colorectal, breast, and thyroid cancer. Additionally, PET-CT is commonly employed to diagnose neurological, cardiovascular, infectious, and inflammatory pathologies, and the CT component is used to detect coronary artery calcification, a marker of coronary atheroscleosis.[45]

The main advantage of PET-CT is the ability to demonstrate metabolic information with precise anatomic detail of multi-slice high-resolution CT images, to the extent that PET-CT has replaced PET in Canada. Medical specialties that commonly use PET-CT imaging include oncology, neurology, cardiology, internal medicine, and orthopedics.

The disadvantages of PET-CT are those of the component modalities, both of which involve exposure to ionizing radiation.[45,49,50] The radioisotopes used in PET-CT have a half-life measured in hours, so imaging depends on availability of a cyclotron and radioisotope transportation.

Positron Emission Tomography–Magnetic Resonance Imaging

Positron emission tomography–magnetic resonance imaging (PET-MRI) combines PET with MRI,[51] permitting high-sensitivity metabolic imaging with high resolution of soft tissue detail, enabling visualization of anatomy and pathologies not commonly attainable with other modalities. The two scans are performed in tandem, and the images are then computationally aligned. PET-MRI is the newest combination to reach clinical use and has applications in oncology, neurology, cardiology, internal medicine, and orthopedics.[52,53]

PET-MRI requires injection of radioisotope tracers, and therefore requires the same risk–benefit assessment as other nuclear medicine imaging modalities for women of reproductive age and children.[43,44] Since the CT component is replaced by MRI, X-ray exposure is avoided; however, the potential hazards of magnetic fields remain.[43,44] The radioisotopes have a short half-life, necessitating proximity to a cyclotron. The units and their infrastructure requirements are extremely expensive.

Picture Archiving and Communication Systems

Picture archiving and communication system (PACS) refers to an electronic system used to digitally manage images, including transmission, filing, storage, distribution, and retrieval of medical images. It is networked and frequently Web-based. Combined with other Web-based telehealth technologies, PACS allows timely access to medical images and specialists. PACS has replaced film and film library systems.

Access to images outside medical imaging departments by referring and consulting physicians is important for efficient patient care, particularly in a country like Canada, with its geographic size and dispersed population.

Appendix B: Survey Questions for the 2017 Canadian Medical Imaging Inventory

Questions marked with an asterisk (*) were mandatory.

CMII Survey Questions 2017	
Site and facility information	Name of Site: Street Address: Suite: City: Province: Postal code:
	*What type of facility is this? • Hospital An institution where patients are provided with continuing medical care, and supporting diagnostic and therapeutic services. Hospitals are licensed or approved as hospitals by a provincial or territorial government or are operated by the Government of Canada. Included are those providing acute care. • Tertiary care A hospital that provides tertiary care, which is health care from specialists who investigate and treat patients in a large hospital after referral from primary care and secondary care facilities. • Community hospital A short-term (average length of stay with fewer than 30 days) hospital that provides acute care. • Free-standing Ranges from specialized services run privately by physicians, radiologists, dentists, chiropractors, or via mammography programs to broad-based imaging centres offering a wide range of tests.
	*In which of the following settings are you located: • Urban • Rural • Remote
	*Facility Department: Comment box
	*How is this facility[1] funded? [1]A single hospital or a hospital campus site that is part of an amalgamation of hospitals. • Public • Private • Both (please provide details) (comment box)
Picture archiving and communication system (PACS)	Are medical images stored in a picture archiving and communication system (PACS)? • Yes • No • Don't know

	If yes, which imaging modalities are stored on PACS? (check all that apply) • CT • MRI • SPECT • PET-CT or PET • PET-MRI • SPECT-CT
	Is your PACS • Local (institutional) • Regional • Provincial
	Do referring physicians have access to PACS images in areas of the hospital outside of diagnostic imaging (e.g., hospital clinics, the OR, case rounds meeting rooms, etc.)? • Yes • No • Don't know
	Are PACS images routinely accessible throughout your provincial health care system without the need to manually push images from any particular location/modality? • Yes • No • Don't know
	Do you have a process for determining the appropriateness of orders that are received? • Yes • No • Don't know
CT: machine types	Do you have the following types of machines at the site? • CT • MRI • SPECT • PET-CT or PET • PET-MRI • SPECT-CT
	Do you have plans to install the following in the next two years? • CT • MRI • SPECT • PET-CT or PET • PET-MRI • SPECT-CT

CT: make and model	* What is the make of the CT unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
	* What is the model of the CT unit? Comment box
	* What year did (or will) the CT unit become operational? 2000–2019
	* Has this unit been decommissioned? • Yes • No • Don't know If yes, what year was it decommissioned? 2000–2019
CT: individual unit specifications	Is this CT unit new or previously used? • New • Previously used
	How many multidetectors does the CT unit have (how many slices)? 1,2,4,6,8,16,32,40,64,128,256,264,320,Other If "Other" is selected, please comment.
	Does the CT unit have a dual-energy option? • Yes • No • Don't know
	Does the CT unit have a dual-target option? • Yes • No • Don't know
	Does the CT unit have dose-management controls? • Yes • No • Don't know
	Does the CT unit incorporate image reconstruction techniques for dose reduction? • Yes • No • Don't know
	Does the CT unit record patient radiation dose by exam (e.g., as a save screen on PACS)? • Yes • No • Don't know

	Is the CT unit mobile[1]? [1] Imaging equipment that travels to two or more communities to provide radiological services. • Yes • No • Don't know If yes, please include the names of the sites that share the CT unit: Comment Box
	Is this CT unit a replacement for an existing CT unit? Please add the make and year of installation of the CT unit that is being replaced. • Yes • No • Don't know Replacement unit make – Comment Box Replaced unit year – Comment Box
CT: usage	For all CT units, how many examinations[1] on average were conducted in the last fiscal year? [1] An imaging exam is defined as a single medical imaging session using an imaging modality to study one (or more than one) body structure, body system, or anatomical area that yields one or more views for diagnostic and/or therapeutic purposes. Comment Box
	In an average 168-hour week, how many hours are the CT units in use? (Please average the hours for all units and express them as the total number of hours)
	In a regular 24-hour workday, how many hours are the CT units in use. (Please average the hours for all units and express them as the total number of hours)
	Do any CT units operate on the weekend? • Yes • No • Don't know
	Do any CT units operate 24 hours a day? • Yes • No • Don't know
	Based on your experience in the last fiscal year, what is the average percentage of overall time CT units are used for? (The total percentage, expressed as a number, must add up to 100.) • Non-cardiac clinical purposes • Dedicated cardiac purposes, only • Research purposes • Other

	On average what per cent of these exams fall into the following categories? • Oncology • Respiratory disease • Hepatobiliary/GI • Musculoskeletal disorders • Inflammatory or Infectious diseases • Neurological • Cardiac • Trauma • Other
	Are the CT units also used for radiation therapy treatment planning? • Yes • No • Don't know
	Have you decommissioned a CT unit since January 2, 2015? • Yes • No • Don't know If yes, what year was the CT unit decommissioned? 1995–2016
	What year was the decommissioned CT unit originally installed? 1995–2016
	What was the make of the decommissioned CT unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
MRI: make and model	* What is the make of the MRI unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
	* What is the model of the MRI unit? Comment box

	* What year did (or will) the MRI unit become operational? 2000–2019
	* Has this unit been decommissioned? • Yes • No • Don't know If yes, what year was it decommissioned? 2000–2019
MRI: individual unit specifications	Is this MRI unit new or previously used? • New • Previously used
	What is the field strength (Tesla) of the MRI unit? 1.5 3 5 7 Other If "Other" is selected, please comment.
	What is the configuration of the MRI unit? • Closed bore – normal • Closed bore – wide • Open bore
	Is the MRI unit mobile[1]? [1] Imaging equipment that travels to two or more communities to provide radiological services. • Yes • No • Don't know If yes, please include the names of the sites that share the MRI unit: Comment Box
	Is this MRI unit a replacement for an existing MRI unit? Please add the make and year of installation of the MRI unit that is being replaced. • Yes • No • Don't know Replacement unit make – Comment Box Replaced unit year – Comment Box

MRI: usage	For all MRI units, how many examinations[1] on average were conducted in the last fiscal year? [1] An imaging exam is defined as a single medical imaging session using an imaging modality to study one (or more than one) body structure, body system, or anatomical area that yields one or more views for diagnostic and/or therapeutic purposes. Comment Box
	In an average 168-hour week, how many hours are the MRI units in use? (Please average the hours for all units and express them as the total number of hours)
	In a regular 24-hour workday, how many hours are the MRI units in use? (Please average the hours for all units and express them as the total number of hours)
	Do any MRI units operate on the weekend? • Yes • No • Don't know
	Do any MRI units operate 24 hours a day? • Yes • No • Don't know
	Based on your experience in the last fiscal year, what is the average percentage of overall time MRI units are used for? (The total percentage, expressed as a number, must add up to 100.) • Non-cardiac clinical purposes • Dedicated cardiac purposes, only • Research purposes • Other
	On average, what per cent of these exams fall into the following categories? • Oncology • Respiratory disease • Hepatobiliary/GI • Musculoskeletal disorders • Neurological • Cardiac • Trauma • Other
	Have you decommissioned an MRI unit since January 2, 2015? • Yes • No • Don't know If yes, what year was the MRI unit decommissioned? 1995–2016

	What year was the decommissioned MRI unit originally installed? 1995–2016
	What was the make of the decommissioned MRI unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
SPECT: Make and Model	* What is the make of the SPECT unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
	* What is the model of the SPECT unit? Comment box
	* What year did (or will) the SPECT unit become operational? 2000-2019
	* Has this unit been decommissioned? • Yes • No • Don't know If yes, what year was it decommissioned? 2000-2019
SPECT: individual unit specifications	Is this SPECT unit new or previously used? • New • Previously used
	Is this a dedicated cardiac SPECT unit? • Yes • No • Don't know
	How many multidetectors does the CT unit have (how many slices)? 1,2,4,6,8,16,32,40,64,128,256,264,320,Other If "Other" is selected, please comment.

	How many detector heads does the SPECT unit have? 1,2,3
	What type of view does the SPECT unit have? • Standard, multipurpose • Dedicated, limited • Other
	What type of software is used for the SPECT unit? • Filtered back projection • Interactive reconstruction
	Is the SPECT unit mobile[1]? [1] Imaging equipment that travels to two or more communities to provide radiological services. • Yes • No • Don't know If yes, please include the names of the sites that share the SPECT unit: Comment Box
	Is this SPECT unit a replacement for an existing SPECT unit? Please add the make and year of installation of the SPECT unit that is being replaced. • Yes • No • Don't know Replacement unit make – Comment Box Replaced unit year – Comment Box
SPECT: usage	For all SPECT units, how many examinations[1] on average were conducted in the last fiscal year? [1] An imaging exam is defined as a single medical imaging session using an imaging modality to study one (or more than one) body structure, body system, or anatomical area that yields one or more views for diagnostic and/or therapeutic purposes. Comment Box
	In an average 168-hour week, how many hours are the SPECT units in use? (Please average the hours for all units and express them as the total number of hours)
	In a regular 24-hour workday, how many hours are the SPECT units in use? (Please average the hours for all units and express them as the total number of hours)
	Do any SPECT units operate on the weekend? • Yes • No • Don't know
	Do any SPECT units operate 24 hours a day? • Yes • No • Don't know

	Based on your experience in the last fiscal year, what is the average percentage of overall time SPECT units are used for? (The total percentage, expressed as a number, must add up to 100.) • Non-cardiac clinical purposes • Dedicated cardiac purposes, only • Research purposes • Other
	On average, what per cent of these exams fall into the following categories? • Oncology • Respiratory disease • Hepatobiliary/GI • Musculoskeletal disorders • Inflammatory or Infectious diseases • Neurological • Cardiac • Thyroid/parathyroid/ other endocrine • Other
	Are the SPECT units also used for radiation therapy treatment planning? • Yes • No • Don't know
	Have you decommissioned a SPECT unit since January 2, 2015? • Yes • No • Don't know If yes, what year was the SPECT unit decommissioned? 1995–2016
	What year was the decommissioned SPECT unit originally installed? 1995–2016
	What was the make of the decommissioned SPECT unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
PET or PET-CT: make and model	* What is the make of the PET-CT or PET unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
	* What is the model of the PET-CT or PET unit? Comment box

	* What year did (or will) the PET-CT or PET unit become operational? 2000-2019
	* Has this unit been decommissioned? • Yes • No • Don't know If yes, what year was it decommissioned? 2000–2019
PET or PET-CT: individual unit specifications	Is this PET-CT or PET unit new or previously used? • New • Previously used
	What is the imaging scope of the PET-CT or PET unit? Head only Near whole body/full body
	How many slices does the CT component of the PET-CT unit have? 1,2,4,6,8,16,32,40,64,128,256,264,320,Other If "Other" is selected, please comment.
	Do you use the CT component of your PET-CT or PET unit as a stand-alone CT unit for clinical CT examinations (i.e., to provide extra CT capacity)? • Yes • No • Don't know
	Does the PET-CT or PET unit have dose-management controls? • Yes • No • Don't know
	Does the PET-CT or PET unit incorporate image reconstruction techniques for dose reduction? • Yes • No • Don't know
	Does the PET-CT or PET unit record patient CT radiation dose (e.g., as a save screen on PACS)? • Yes • No • Don't know
	Is the PET-CT or PET unit mobile[1]? [1] Imaging equipment that travels to two or more communities to provide radiological services. • Yes • No • Don't know If yes, please include the names of the sites that share the PET-CT or PET unit: Comment Box

	Is this PET-CT or PET unit a replacement for an existing PET-CT or PET unit? Please add the make and year of installation of the PET-CT or PET unit that is being replaced. • Yes • No • Don't know Replacement unit make – Comment Box Replaced unit year – Comment Box
PET or PET-CT: usage	For all PET-CT or PET units, how many examinations[1] on average were conducted in the last fiscal year? [1] An imaging exam is defined as a single medical imaging session using an imaging modality to study one (or more than one) body structure, body system, or anatomical area that yields one or more views for diagnostic and/or therapeutic purposes. Comment Box
	In an average 168-hour week, how many hours are the PET-CT or PET units in use? (Please average the hours for all units and express them as the total number of hours)
	In a regular 24-hour workday, how many hours are the PET-CT or PET units in use? (Please average the hours for all units and express them as the total number of hours)
	Do any PET-CT or PET units operate on the weekend? • Yes • No • Don't know
	Do any PET-CT or PET units operate 24 hours a day? • Yes • No • Don't know
	Based on your experience in the last fiscal year, what is the average percentage of overall time PET-CT or PET units are used for? (The total percentage, expressed as a number, must add up to 100.) • Non-cardiac clinical purposes • Dedicated cardiac purposes, only • Research purposes • Other
	On average what per cent of these exams fall into the following categories? • Oncology • Cardiac • Inflammatory or Infectious diseases • Neurological • Other
	Are the PET-CT or PET units also used for radiation therapy treatment planning? • Yes • No • Don't know

	Does your facility[1] operate a cyclotron for the PET-CT or PET units? [1] A single hospital or a hospital campus site that is part of an amalgamation of hospitals. • Yes • No • Don't know If yes, please describe the make and model of the cyclotron, if it is single or dual beam, and the energy level or energy level range (MeV). Comment Box
	Have you decommissioned a PET-CT or PET unit since January 2, 2015? • Yes • No • Don't know If yes, what year was the PET-CT or PET unit decommissioned? 1995–2016
	What year was the decommissioned PET-CT or PET unit originally installed? 1995–2016
	What was the make of the decommissioned PET-CT or PET unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
PET-MRI: make and model	* What is the make of the PET-MRI unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
	* What is the model of the PET-MRI unit? Comment box
	* What year did (or will) the PET-MRI unit become operational? 2000–2019
	* Has this unit been decommissioned? • Yes • No • Don't know If yes, what year was it decommissioned? 2000–2019

PET-MRI: individual unit specifications	Is this PET-MRI unit new or previously used? • New • Previously used
	What is the imaging scope of the PET-MRI unit? • Head only • Near whole body/full body
	Is the PET-MRI unit mobile[1]? [1] Imaging equipment that travels to two or more communities to provide radiological services. • Yes • No • Don't know If yes, please include the names of the sites that share the PET-MRI unit: Comment Box
	Is this PET-MRI unit a replacement for an existing PET-MRI unit? Please add the make and year of installation of the PET-MRI unit that is being replaced. • Yes • No • Don't know Replacement unit make – Comment Box Replaced unit year – Comment Box
	* What is the make of the SPECT-CT unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.
	* What is the model of the SPECT-CT unit? Comment box
	* What year did (or will) the SPECT-CT unit become operational? 2000-2019
	* Has this unit been decommissioned? • Yes • No • Don't know If yes, what year was it decommissioned? 2000–2019
SPECT-CT: individual unit specifications	Is this SPECT-CT unit new or previously used? • New • Previously used
	Is this a dedicated cardiac SPECT-CT unit? • Yes • No • Don't know

	How many multidetectors does the SPECT-CT unit have (how many slices)? 1,2,4,6,8,16,32,40,64,128,256,264,320,Other If "Other" is selected, please comment.
	How many detector heads does the SPECT-CT unit have? 1,2,3
	What type of view does the SPECT-CT unit have? • Standard, multipurpose • Dedicated, limited • Other
	What type of software is used for the SPECT-CT unit? • Filtered back projection • Interactive reconstruction
	Do you use the CT component of your SPECT-CT unit as a stand-alone CT unit for clinical CT examinations (i.e., to provide extra CT capacity)? • Yes • No • Don't know
	Does the SPECT-CT unit have dose management controls? • Yes • No • Don't know
	Does the SPECT-CT unit incorporate image reconstruction techniques for dose reduction? • Yes • No • Don't know
	Does the SPECT-CT unit record patient CT radiation dose (e.g., as a save screen on PACS)? • Yes • No • Don't know
	Is the SPECT-CT unit mobile[1]? [1] Imaging equipment that travels to two or more communities to provide radiological services. • Yes • No • Don't know If yes, please include the names of the sites that share the SPECT-CT unit: Comment Box
	Is this SPECT-CT unit a replacement for an existing SPECT-CT unit? Please add the make and year of installation of the SPECT-CT unit that is being replaced. • Yes • No • Don't know Replacement unit make – Comment Box Replaced unit year – Comment Box

SPECT-CT: usage	For all SPECT-CT units, how many examinations[1] on average were conducted in the last fiscal year? [1] An imaging exam is defined as a single medical imaging session using an imaging modality to study one (or more than one) body structure, body system, or anatomical area that yields one or more views for diagnostic and/or therapeutic purposes. Comment Box
	In an average 168-hour week, how many hours are the SPECT-CT units in use? (Please average the hours for all units and express them as the total number of hours)
	In a regular 24-hour workday, how many hours are the SPECT-CT units in use. (Please average the hours for all units and express them as the total number of hours)
	Do any SPECT-CT units operate on the weekend? • Yes • No • Don't know
	Do any SPECT-CT units operate 24 hours a day? • Yes • No • Don't know
	Based on your experience in the last fiscal year, what is the average percentage of overall time SPECT-CT units are used for? (The total percentage, expressed as a number, must add up to 100.) • Non-cardiac clinical purposes • Dedicated cardiac purposes, only • Research purposes • Other
	On average what per cent of these exams fall into the following categories. • Oncology • Respiratory disease • Hepatobiliary/GI • Musculoskeletal disorders • Inflammatory or Infectious diseases • Neurological • Cardiac • Thyroid/parathyroid/ other endocrine • Other
	Are the SPECT-CT units also used for radiation therapy treatment planning? • Yes • No • Don't know
	Have you decommissioned a SPECT-CT unit since January 2, 2015? • Yes • No • Don't know If yes, what year was the SPECT-CT unit decommissioned? 1995–2016
	What year was the decommissioned SPECT-CT unit originally installed? 1995–2016

	What was the make of the decommissioned SPECT-CT unit? GE Healthcare Hitachi Philips Siemens Toshiba Other If "Other" is selected, please comment.

CT = computed tomography; GE = General Electric; GI = gastrointestinal; MRI = magnetic resonance imaging; PACS = picture archiving and communication system; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

* Compulsory question.

Appendix C: Details of Facilities Responding to the Canadian Medical Imaging Inventory 2015 Update

Table 18: Summary of Type of Facility Included in the Canadian Medical Imaging Inventory 2017 Update

Province/Territory	Number of Sites[a,b]			
	Hospital	Community Hospital	Tertiary Care	Free-Standing
Alberta	29 (70.7)	8 (19.5)	1 (2.4)	3 (7.3)
British Columbia	33 (56.9)	7 (12.1)	4 (6.9)	14 (24.1)
Manitoba	1 (6.7)	11 (73.3)	2 (13.3)	1 (6.7)
New Brunswick	10 (100)			
Newfoundland and Labrador	10 (76.9)		1 (7.7)	2 (15.4)
Northwest Territories	1 (100)			
Nova Scotia	7 (41.2)	2 (11.8)	5 (29.4)	3 (17.6)
Nunavut	1 (100)			
Ontario	55 (63.2)	23 (26.4)	3 (3.4)	6 (6.9)
Prince Edward Island	2 (100)			
Quebec	45 (75)	2 (3.3)	5 (8.3)	8 (13.3)
Saskatchewan	13 (76.5)		1 (5.9)	3 (17.6)
Yukon	1 (100)			
All	209 (64.5)	53 (16.4)	22 (6.8)	40 (12.3)

[a] Data derived from survey question: "What type of facility is this?" The four categories are mutually exclusive.

[b] Sites that did not provide this information are not included in this table.

Table 19: Summary of Location of Facilities Included in the Canadian Medical Imaging Inventory 2017 Update

Province/Territory	Number of Sites[a,b]		
	Urban	Rural	Remote
Alberta	20 (50)	19 (47.5)	1 (2.5)
British Columbia	34 (70.8)	13 (27.1)	1 (2.1)
Manitoba	7 (50)	5 (35.7)	2 (14.3)
New Brunswick	2 (66.7)	1 (33.3)	
Newfoundland and Labrador	2 (33.3)	4 (66.7)	
Northwest Territories			1 (100)
Nova Scotia	9 (60)	6 (40)	
Ontario	34 (75.6)	11 (24.4)	
Prince Edward Island	2 (100)		
Quebec	33 (89.2)	4 (10.8)	
Saskatchewan	10 (90.9)	1 (9.1)	
Canada	154 (69.1)	64 (28.7)	5 (2.2)

[a] Data derived from survey question: "In which of the following settings are you located?"

[b] Sites that did not provide this information are not included in this table. No responses are available for Nunavut and Yukon.

Table 20: Summary of Source of Funding for Sites Included in the Canadian Medical Imaging Inventory 2017 Update

Province/Territory	Number of Sites[a,b]		
	Publicly	Privately	Both
Alberta	40 (97.6)		1 (2.4)
British Columbia	43 (75.4)	13 (22.8)	1 (1.8)
Manitoba	15 (100)		
New Brunswick	7 (100)		
Newfoundland and Labrador	13 (100)		
Northwest Territories	2 (100)		
Nova Scotia	15 (93.8)	1 (6.2)	
Ontario	90 (93.8)	4 (4.2)	2 (2.1)
Prince Edward Island	2 (100)		
Quebec	49 (81.7)	8 (13.3)	3 (5)
Saskatchewan	15 (83.3)	1 (5.6)	2 (11.1)
Yukon			1 (100)
Canada	209 (64.5)	53 (16.4)	40 (12.3)

[a] Data derived from survey question: "How is this facility funded?"

[b] Sites that did not provide this information are not included in this table. No response was available for Nunavut.

Appendix D: Summaries of Use Data

Table 21: Number of Exams Reported for the Most Recent Fiscal Year for All Modalities Across All Provinces

Province/Territory	Number of Exams					
	CT	MRI	PET-CT	PET-MRI	SPECT	SPECT-CT
Alberta	405,332[a]	192,375[a]	11,050[a]	0	17,996[a]	8,134[a]
British Columbia	695,248[b]	173,678[b]	9,280[b]	0	103,665[c]	44,913[c]
Manitoba	186,197	77,735	2,009	0	11,120	10,954
New Brunswick	142,294	44,592	1,808	0	15,067[d,e]	3,262[e]
						21,306[f]
Newfoundland and Labrador	90,985	20,990	0	0	21,949[g]	589[h]
						27,297[c]
Northwest Territories	4,695	0	0	0	0	0
Nova Scotia	155,099	47,490	2,512	0	9610[g]	15,803
Nunavut	2,000	0	0	0	0	0
Ontario	2,430,739	866,953	10,998[i]	5[c]		200,833[j]
Prince Edward Island	15,811	4,279	0	0	0	2,299[j]
Quebec	1,350,792	380,357	50,823	0		786,594[j]
Saskatchewan	128,415	44,461	2,050	0	Not available[k]	52,730[c]
Yukon	3,500	0	0	0	0	0
Canada	5,611,107	1,855,110	90,530	0		1,354,121

CT = computed tomography; MRI = magnetic resonance imaging; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

[a] Exams from Alberta Health Services only.

[b] Exams from public sites only.

[c] No validator information. Estimated from survey data, question: "For all [modality] units, how many examinations on average were conducted in the last fiscal year?"

[d] Exams from Horizon Health Network.

[e] All nuclear medicine exams, excluding bone density.

[f] Exams from Vitalite Health Network.

[g] Figures available for all nuclear medicine exams only.

[h] Validated data from one site.

[i] Does not include public funding through special access, registries, or evidence-building trials.

[j] Validated data only available for SPECT and SPECT-CT.

[k] Insufficient data to allow imputation.

Table 22: Summary of Average Hours per Day of Use for All Modalities Across All Provinces

Province/Territory		Average Hours per Day [a,c]					
		CT	MRI	PET-CT	PET-MRI	SPECT	SPECT-CT
Alberta	n [b]	35	23	3	NA	10	15
	mean	10.7	11	10		8.9	8.9
	min-max	(0.5 to 24)	(2 to 17)	(8 to 12)		(5 to 16)	(6 to 16)
British Columbia	n [b]	34	22	1	NA	9	11
	mean	13.3	12.6	14.5		9.9	8.8
	min-max	(6 to 24)	(7.5 to 24)	(14.5 to 14.5)		(8 to 17)	(8 to 10)
Manitoba	n [b]	14	7	1	NA	4	4
	mean	12.9	14.2	8		8.4	8.4
	min-max	(8 to 22)	(9 to 17)	(8 to 8)		(8 to 9.5)	(8 to 9.5)
New Brunswick	n [b]	6	6	1	NA	1	3
	mean	9.5	9.2	6		8	8.3
	min-max	(8 to 11)	(7.5 to 10)				(8 to 9)
Newfoundland and Labrador	n [b]	12	5	NA	NA	2	3
	mean	9.6	12.1			7	9.3
	min-max	(5 to 19)	(7 to 14)				(7 to 14)
Northwest Territories	n [b]	1	NA	NA	NA	NA	NA
	mean	8.5					
	min-max						
Nova Scotia	n [b]	15	10	1	NA	5	8
	mean	11.1	11.8	8		8.3	8.5
	min-max	(8 to 24)	(9 to 16)			(8 to 9)	(8 to 9)
Ontario	n [b]	57	35	6	1	37	34
	mean	13.1	16.2	6.3	12	9	9
	min-max	(2.4 to 24)	(2.5 to 24)	(1 to 9)		(6.5 to 22.5)	(3 to 16)
Prince Edward Island	n [b]	2	1	NA	NA	NA	2
	mean	8.5	12				8
	min-max	(8.5 to 8.5)					
Quebec	n [b]	35	30	12	NA	5	5
	mean	12.9	12.7	9.2		9.7	10.8
	min-max	(4 to 24)	(6 to 24)	(4 to 15.8)		(7.5 to 16)	(8 to 16)
Saskatchewan	n [b]	13	5	1	NA	1	3
	mean	11.7	13.6	8		8	7
	min-max	(1 to 24)	(8 to 17.5)				
Yukon	n [b]	1	1	NA	NA	NA	NA
	mean	8	9				
	min-max						

CT = computed tomography; MRI = magnetic resonance imaging; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

[a] Data derived from survey question: "In a regular 24-hour workday, how many hours are the [modality] units in use?"

[b] Number of sites contributing responses. Sites that did not provide responses are not included in these summaries.

[c] NA indicates data not available, either because province does not have modality, or no sites reported examination data. No data are available for Nunavut.

Table 23: Summary of 24-Hour Use for All Modalities Across All Provinces

Province/Territory	Numbera, b (%) of Sites With 24-Hour Use		
	CT	MRI	PET-MRI
Alberta	8 (25)	1 (6.2)	0
British Columbia	13 (44.8)	1 (6.2)	0
Manitoba	3 (25)	0 (0)	0
New Brunswick	0 (0)	0 (0)	0
Newfoundland and Labrador	0 (0)	0 (0)	0
Northwest Territories	0 (0)	0	0
Nova Scotia	14 (100)	1 (14.3)	0
Ontario	17 (51.5)	7 (33.3)	1 (100)
Prince Edward Island	0 (0)	0 (0)	0
Quebec	8 (50)	1 (7.1)	0
Saskatchewan	2 (28.6)	0 (0)	0

CT = computed tomography; MRI = magnetic resonance imaging; PET-MRI = positron emission tomography–magnetic resonance imaging.

[a] Data derived from survey question: "Do any [modality] units operate on 24 hours a day?"

[b] Sites that did not provide responses are not included in these summaries. No data are available for Nunavut and Yukon.

Table 24: Average Hours per Week of Use for All Modalities Across All Provinces

Province/Territory		Average Hours per Week [a,c]					
		CT	MRI	PET-CT	PET-MRI	SPECT	SPECT-CT
Alberta	n [b] mean min-max	35 63.1 (1 to 168)	23 63.2 (10 to 128)	3 50 (40 to 60)	NA	10 44.8 (25 to 80)	15 45.8 (30 to 96)
British Columbia	n [b] mean min-max	35 88.3 (25.29 to 168)	21 70.5 (24 to 152)	1 79	NA	9 46.2 (8 to 85)	11 44.1 (40 to 50)
Manitoba	n [b] mean min-max	14 80.1 (40 to 146)	7 93.5 (45 to 119)	1 40	NA	4 42.2 (40 to 47.5)	4 42.2 (40 to 47.5)
New Brunswick	n [b] mean min-max	6 61.8 (52.5 to 77)	6 45 (24 to 70)	1 18	NA	2 40 (40 to 40)	3 41.7 (40 to 45)
Newfoundland and Labrador	n [b] mean min-max	12 52.4 (24 to 95)	5 60.5 (35 to 70)	NA	NA	2 35 (35 to 35)	3 46.7 (35 to 70)
Northwest Territories	n [b] mean min-max	1 47	NA	NA	NA	NA	NA
Nova Scotia	n [b] mean min-max	15 65.8 (32.5 to 168)	10 68.2 (45 to 123)	1 32	NA	5 41.5 (40 to 45)	8 42.5 (40 to 45)
Ontario	n [b] mean min-max	56 82.9 (22.5 to 168)	35 108.6 (37.5 to 168)	5 29 (5 to 45)	1 100	37 43.1 (30 to 80)	34 46.1 (15 to 88)
Prince Edward Island	n [b] mean min-max	2 46.5 (42.5 to 50.5)	1 60	NA	NA	NA	2 42.5
Quebec	n [b] mean min-max	36 85.9 (12 to 168)	30 72 (30 to 134)	12 42.9 (10 to 79)	NA	5 49.4 (40 to 80)	5 54 (40 to 80)
Saskatchewan	n [b] mean min-max	14 74 (1 to 168)	5 84.4 (40 to 115.5)	1 30	NA	1 40	3 35 (35 to 35)
Yukon	n [b] mean min-max	1 40	1 40	NA	NA	NA	NA

CT = computed tomography; MRI = magnetic resonance imaging; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

[a] Data derived from survey question: "In a regular 168-hour work week, how many hours are the [modality] units in use?"

[b] Number of sites contributing responses. Sites that did not provide responses are not included in these summaries. No data are available for Nunavut and Yukon.

[c] NA indicates data not available, either because province does not have modality, or no sites reported data. No data are available for Nunavut.

Table 25: Summary of Weekend Use for All Modalities Across All Provinces

Province/Territory	Number[a, b] (%) of Sites With Weekend Use					
	CT	MRI	PET-CT	PET-MRI	SPECT	SPECT-CT
Alberta	17 (48.6)	9 (39.1)	0 (0)	0	0 (0)	1 (6.7)
British Columbia	30 (83.3)	15 (68.2)	1 (100)	0	2 (20)	2 (16.7)
Manitoba	10 (71.4)	6 (85.7)	0 (0)	0	1 (25)	0 (0)
New Brunswick	6 (100)	0 (0)	0 (0)	0	0 (0)	0 (0)
Newfoundland and Labrador	2 (15.4)	0 (0)	0	0	0 (0)	0 (0)
Northwest Territories	1 (100)	0	0	0	0	0
Nova Scotia	15 (100)	3 (30)	0 (0)	0	0 (0)	0 (0)
Ontario	48 (84.2)	31 (86.1)	0 (0)	1 (100)	3 (8.6)	4 (12.5)
Prince Edward Island	2 (100)	0 (0)	0	0	0 (0)	0 (0)
Quebec	33 (91.7)	15 (51.7)	1 (8.3)	0	3 (60)	2 (33.3)
Saskatchewan	10 (71.4)	4 (80)	0 (0)	0	0 (0)	0 (0)

CT = computed tomography; MRI = magnetic resonance imaging; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

[a] Data derived from survey question: "Do any [modality] units operate on the weekend?"

[b] Sites that did not provide responses are not included in these summaries. No data are available for Nunavut and Northwest Territories.

Table 26: Summary of Type of Use (Cardiac, Non-Cardiac, Research and Other)

Type of Use		Average Percentage of Use for Each Category[a]					
		CT	MRI	PET-CT	PET-MRI	SPECT	SPECT-CT
Cardiac	n[b]	157	85	19	1	49	55
	mean	1.3	3.6	12.1	50	26.3	21.5
	min-max	(0 to 15)	(0 to 50)	(0 to 80)		(0 to 100)	(0 to 85)
Non-cardiac	n[b]	159	86	19	1	50	55
	mean	94.6	85.7	80.7	0	73.9	78.1
	min-max	(0 to 100)	(0 to 100)	(20 to 100)		(0 to 100)	(15 to 100)
Other	n[b]	159	85	19	1	50	55
	mean	3.5	4.3	0.4	50	0	0.2
	min-max	(0 to 100)	(0 to 100)	(0 to 7)		(0 to 0)	(0 to 10)
Research	n[b]	159	85	19	1	49	55
	mean	0.6	1.6	6.8	0	0.3	0.1
	min-max	(0 to 30)	(0 to 50)	(0 to 50)		(0 to 10)	(0 to 2)

CT = computed tomography; MRI = magnetic resonance imaging; PET-CT = positron emission tomography–computed tomography; PET-MRI = positron emission tomography–magnetic resonance imaging; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

[a] Data derived from survey question: "Based on your experience in the last fiscal year, what is the average percentage of overall time CT units are used for? (The total percentage, expressed as a number, must add up to 100): Non-cardiac clinical purposes, Dedicated cardiac purposes, only, Research purposes, Other."

[b] Number of sites contributing responses. Sites that did not provide responses are not included in these summaries.

Table 27: Summary of Type of Use (by Discipline) for All Modalities

Type of Use		Average Percentage of Use for Each Category [a]				
		CT	MRI	PET-CT	SPECT	SPECT-CT
Cardiac	n [b]	63	34	13	19	15
	mean	2.3	3.5	10.7	39.8	35.7
	min-max	(0 to 20)	(0 to 35)	(0 to 95)	(0 to 100)	(0 to 100)
Hepatobiliary	n [b]	63	34	13	19	15
	mean	11.5	11.3	0	4.4	2.4
	min-max	(0 to 35)	(0 to 25)	(0 to 0)	(0 to 15)	(0 to 15)
Inflammatory	n [b]	NA [c]	34	13	19	15
	mean		0	1.2	3.2	4.5
	min-max		(0 to 0)	(0 to 5)	(0 to 15)	(0 to 15)
Lymphatic	n [b]	63	34	13	19	15
	mean	0	0	0	2.3	2.3
	min-max	(0 to 0)	(0 to 0)	(0 to 0)	(0 to 8)	(0 to 10)
Musculoskeletal	n [b]	63	34	13	19	15
	mean	8.7	27.3	0	10.4	18.7
	min-max	(0 to 75)	(0 to 70)	(0 to 0)	(0 to 48)	(0 to 90)
Neurological	n [b]	63	34	13	19	15
	mean	18.9	25.4	7	0.3	1.8
	min-max	(0 to 55)	(0 to 45)	(0 to 50)	(0 to 2)	(0 to 20)
Oncology	n [b]	63	34	13	19	15
	mean	23.1	20.8	80.2	24.7	25.3
	min-max	(0 to 100)	(0 to 100)	(0 to 100)	(0 to 100)	(0 to 100)
Other category	n [b]	63	34	13	19	15
	mean	6.8	7.1	0.9	4.1	1.4
	min-max	(0 to 100)	(0 to 100)	(0 to 10)	(0 to 24)	(0 to 7)
Respiratory	n [b]	63	34	13	19	15
	mean	12.6	3.1	0	7.2	4.7
	min-max	(0 to 30)	(0 to 24)	(0 to 0)	(0 to 65)	(0 to 19)
Thyroid	n [b]	63	34	13	19	15
	mean	0	0	0	3.9	3.2
	min-max	(0 to 0)	(0 to 0)	(0 to 0)	(0 to 20)	(0 to 9)
Trauma	n [b]	63	NA [c]	13	19	15
	mean	9.5		0	0	0
	min-max	(0 to 65)		(0 to 0)	(0 to 0)	(0 to 0)

CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography; PET-CT = positron emission tomography–computed tomography; SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography–computed tomography.

[a] Data derived from survey question: "On average what per cent of these exams fall into the following categories?" (Categories varied according to modality).

[b] Number of sites contributing responses. Sites that did not provide responses are not included in these summaries.

[c] NA category was not applicable to that modality.

Appendix E: Comparison of Units and Exams between 2015 and 2017

Table 28: Comparison of Units and Exams Between 2015 and 2017 for CT

Province / Territory	2015		2017		2015		2017	
	Units[a,b]	Units per Million Population[e]	Units[a,b]	Units per Million Population[f]	Exams[c]	Exams per Thousand Population[e]	Exams[d,b]	Exams per Thousand Population[f]
Alberta	50	11.91	56	13.05	382,300	91.1	405,332	94.4
British Columbia	65	13.88	66[g]	13.78	634,530	135.5	695,248	145.2
Manitoba	19	14.69	23	17.26	173,299	134.0	186,197	139.7
New Brunswick	14	18.57	15	19.80	130,984	173.7	142,294	187.8
Newfoundland and Labrador	16	30.31	16	30.26	115,552	218.9	90,985	172.1
Northwest Territories	1	22.68	1	22.53	--	--	4,695	105.8
Nova Scotia	19	22.27	18	18.88	157,290	166.8	155,099	162.7
Nunavut	1	27.10	1	26.69			2,000	53.4
Ontario	186	13.49	184	13.02	1,871,160	135.7	2,430,739	172.0
Prince Edward Island	2	13.66	2	13.35	13,576	92.7	15,811	105.6
Quebec	146	17.67	163[g]	19.47	1,656,662	200.5	1,350,792	161.4
Saskatchewan	16	14.11	15	12.92	139,488	123.0	128,415	110.6
Yukon	1	26.74	1	26.45	3,500	93.6	3,500	92.6
Canada	538	15.01	561	15.33	5,278,341	147.0	5,611,107	153.0

CT = computed tomography.

Source: 2015 data were collected for the 2015 iteration of the Canadian Medical Imaging Inventory.

[a] Unit counts supplied by provincial validators.

[b] Unless otherwise indicated, values (units or exams) include publicly funded sites only.

[c] Total exams for each province were calculated from exams reported by survey respondents, with imputation of missing data. If there were no available data for a province, the total was zero.

[d] Exam data supplied by provincial validators, except where otherwise indicated.

[e] Calculated from the population estimated as of July 1, 2015.

[f] Calculated from the population estimated as of July 1, 2017.

[g] Values include privately funded units.

Table 29: Comparison of Units and Exams Between 2015 and 2017 for MRI

Province / Territory	2015		2017		2015		2017	
	Units[a,b]	Units per million population[e]	Units[a,b]	Units per million population[f]	Exams[c]	Exams per thousand population[e]	Exams[d.b]	Exams per thousand population[f]
Alberta	41	9.77	41	9.55	236,406	56.3	192,375	44.8
British Columbia	42	8.97	46[g]	9.60	154,098	32.9	173,678	36.3
Manitoba	10	7.73	12	9.00	73,460	56.8	77,735	58.3
New Brunswick	10	13.26	11	14.52	41,310	54.8	44,592	58.9
Newfoundland and Labrador	5	9.47	5	9.46	22,265	42.2	20,990	39.7
Northwest Territories	0	0.00	0	0.00	0	0.00	0	0.00
Nova Scotia	11	11.66	12	12.59	44,187	46.9	47,490	49.8
Nunavut	0	0.00	0	0.00	0	0.00	0	0.00
Ontario	125	9.06	120	8.49	974,500	70.7	866,953	61.3
Prince Edward Island	1	6.83	1	6.68	4,567	31.2	4,279	28.6
Quebec	85	10.29	107[g]	12.78	349,945	42.3	380,357	45.4
Saskatchewan	9	7.94	10	8.61	49,122	43.3	44,461	38.3
Yukon	1	26.74	1	26.45	2,200	58.8	2,200	58.2
Canada	340	9.48	366	10.00	1,952,060	54.0	1,855,110	51.0

MRI = magnetic resonance imaging.

Source: 2015 data were collected for the 2015 iteration of the Canadian Medical Imaging Inventory.

[a] Unit counts supplied by provincial validators.

[b] Unless otherwise indicated, values (units or exams) include publicly funded sites only.

[c] Total exams for each province were calculated from exams reported by survey respondents, with imputation of missing data. If there were no available data for a province, the total was zero.

[d] Exam data supplied by provincial validators, except where otherwise indicated.

[e] Calculated from the population estimated as of July 1, 2015.

[f] Calculated from the population estimated as of July 1, 2017.

[g] Values include privately funded units.

Table 30: Comparison of Units and Exams Between 2015 and 2017 for PET-CT

Province / Territory	2015		2017		2015		2017	
	Units[a,b]	Units per million population[e]	Units[a,b]	Units per million population[f]	Exams[c]	Exams per thousand population[e]	Exams[d,b]	Exams per thousand population[f]
Alberta	4	0.95	4	0.93	9,896	2.4	11,050	2.6
British Columbia	3	0.64	3[g]	0.63	8,028	1.7	9,280	1.9
Manitoba	1	0.77	1	0.75	1,741	1.3	2,009	1.5
New Brunswick	2	2.65	2	2.64	1,458	1.9	1,808	2.4
Newfoundland and Labrador	0	0.00	1	1.89	0	0.0	0	0.0
Northwest Territories	0	0.00	0	0.00	0	0.0	0	0
Nova Scotia	1	1.06	1	1.05	2,241	2.4	2,512	2.6
Nunavut	0	0.00	0	0.00			0	0
Ontario	15	1.09	17[g]	1.20	9,825	0.7	10,998	0.8
Prince Edward Island	0	0.00	0	0.00	0	0.0	0	0.0
Quebec	20	2.42	21[g]	2.51	42,320	5.1	50,823	6.1
Saskatchewan	1	0.88	1	0.86	1,315	1.2	2,050	1.8
Yukon	0	0.00	0	0.00			0	0.0
Canada	47	1.31	51	1.39	76,824	2.0	90,530	2.0

PET-CT = positron emission tomography–computed tomography.

Source: 2015 data were collected for the 2015 iteration of the Canadian Medical Imaging Inventory.

[a] Unit counts supplied by provincial validators.

[b] Unless otherwise indicated, values (units or exams) include publicly funded sites only.

[c] Total exams for each province were calculated from exams reported by survey respondents, with imputation of missing data. If there were no available data for a province, the total was zero.

[d] Exam data supplied by provincial validators, except where otherwise indicated.

[e] Calculated from the population estimated as of July 1, 2015.

[f] Calculated from the population estimated as of July 1, 2017.

[g] Values include privately funded units.

Table 31: Comparison of Units and Exams Between 2015 and 2017 for SPECT and SPECT-CT

Province / Territory	2015		2017		2015		2017	
	Units[a,b]	Units per million population[e]	Units[a,b]	Units per million population[f]	Exams[c]	Exams per thousand population[e]	Exams[d.b]	Exams per thousand population[f]
Alberta	65	15.49	74	17.25	107,325	25.8	26,130	6.1
British Columbia	53	11.32	59	12.32	86,264	18.4	148,578	31.0
Manitoba	15	11.6	17	12.75	22,935	17.7	22,074	16.6
New Brunswick	6	7.96	10	13.2	12,000	15.9	39,635	52.3
Newfoundland and Labrador	9	17.05	11	20.8			49,835	94.3
Northwest Territories	0	0	17	17.83			25,413	26.7
Nova Scotia	16	16.96	0	0	18,633	19.8	0	0.0
Nunavut	0	0	0	0			0	0.0
Ontario	137	9.94	229	16.2	248,494	18.0	200,833	14.2
Prince Edward Island	2	13.66	2	13.35	2,119	14.5	2,299	15.3
Quebec	156	18.88	153[g]	18.28	939,700	113.7	786,594	94.0
Saskatchewan	19	16.76	19	16.36	47,826	42.2	52,730	45.4
Yukon	0	0	0	0			0	0.0
Canada	478	13.33	591	16.15	1,485,296	41.4	1,354,121	37.0

SPECT = single-photon emission computed tomography; SPECT-CT = single-photon emission computed tomography– computed tomography.

Source: 2015 data were collected for the 2015 iteration of the Canadian Medical Imaging Inventory.

[a] Unit counts supplied by provincial validators.

[b] Unless otherwise indicated, values (units or exams) include publicly funded sites only.

[c] Total exams for each province were calculated from exams reported by survey respondents, with imputation of missing data. If there were no available data for a province, the total was zero.

[d] Exam data supplied by provincial validators, except where otherwise indicated.

[e] Calculated from the population estimated as of July 1, 2015.

[f] Calculated from the population estimated as of July 1, 2017.

[g] Values include privately funded units.