CADTH Health Technology Review

Canadian Medical Imaging Inventory 2022–2023: Methods

CMII Report

Table of Contents

List of Tables

Abbreviations

CMII	Canadian Medical Imaging Inventory
CT	computed tomography
FTE	full-time equivalent
MRI	magnetic resonance imaging
OECD	Organisation for Economic Co-operation and Development
PACS	picture archiving and communication system
PET	positron emission tomography
SPECT	single-photon emission computed tomography

The Canadian Medical Imaging Inventory

The Canadian Medical Imaging Inventory (CMII) was created in 2015 to track, compare, and map trends over time related to the availability, distribution, technical specifications, and use of advanced imaging equipment in Canada (i.e., computed tomography [CT], magnetic resonance imaging [MRI], positron emission tomography [PET]-CT, PET-MRI, single-photon emission computed tomography [SPECT], and SPECT-CT). This is the fourth iteration of the CMII since CADTH resumed the collection of this data in 2015. Previously, from 2003 to 2012, the Canadian Institute for Health Information (CIHI) collected data on medical imaging technologies in Canada.

The CMII collects data through a survey conducted approximately once every 2 years and details the use of strategies for improving appropriate imaging, enhancing system efficiencies, reducing wait lists, and addressing other systemic challenges.

Robust data are required to ensure health systems can deliver the imaging required to provide timely, safe, patient-centred care; improve health outcomes; and deliver health care efficiencies. The data collected by the CMII can be used by decision-makers for the following purposes:

- to identify gaps in service
- to inform benchmark practices
- to help optimize existing capacity
- to define outcomes and promote processes that are responsive to patients, workforce, and health system needs
- to identify sustainable solutions to promote health care system resilience
- to enable data-driven decision-making and highlight system-level pressure points to improve service delivery and reduce wait times
- to monitor the adoption of innovations within medical imaging
- to identify implementation concerns associated with the introduction of new drug therapies and innovations outside medical imaging
- to understand existing and future demand for services
- to help decision-makers to plan for future sustainability
- to compare Canada's inventory with that of other countries.

Methodology and Analysis

Data about CT, MRI, PET-CT, PET-MRI, SPECT, and SPECT-CT availability and use were primarily collected via a web-based survey. Both English- and French-language versions were offered.

The 2022−2023 survey was based on the 2019−2020 iteration of the survey,[1] with the following change:

- questions were added related to portable CTs and portable MRIs.

The survey respondents who had participated in previous iterations of the inventory[1-3] were presented with prepopulated forms for updating and completion. The respondents for new sites were identified by jurisdiction validators and other imaging professionals and were provided with blank forms.

Prepopulation data were obtained from the following sources:

- site-level data from the CMII 2019−2020 survey, including site survey responses (supplemented by data validators) and a supplementary grey literature search conducted for the 2019−2020 report
- unit-level (technical) data from the CMII 2019−2020 survey.

Sites with name changes were updated and verified via web searches and/or by contacting the facility directly. Data for sites that were identified as being closed (by web search or respondent or validator communication) were archived.

The site-level data collected consisted of the availability of each modality, as well as, for each modality:

- the total number of exams in the last fiscal year across all units (some sites had only the last calendar year available and reported that)
- the average hours of use per day and per week (through regularly scheduled service capacity) and 24-hour and weekend use
- the total planned and unplanned downtime for maintenance and the principal type of maintenance contract
- the number of full-time equivalent technologists (collectively for units of the same type)
- the use of artificial intelligence (AI) for various imaging-related tasks
- the use of clinical decision support tools
- the use of paper forms or telephone requests or fax requests
- for sites with PET-CT, the source of isotopes, the type of isotopes used, and whether used for clinical or research purposes
- for sites reporting mobile units, which other sites shared their units, and for sites reporting portable units, which departments shared the unit.

Site-level data also included the type of facility, the use of picture archiving and communication system (PACS), and the proportions of funding received from different sources (e.g., public, private).

The unit-level information collected consisted of, for each unit:

- the manufacturer, model, and year of installation
- whether units were installed new or used and whether a newly installed unit replaced a preexisting unit
- the modality-specific technical characteristics, the number of detectors and/or slices for CT, the field strength for MRI, and the image scope for SPECT-CT.

The 2022–2023 survey respondents were asked to update the available data to reflect the status as of the time of their survey response. If they did not update the survey, it was assumed that no changes had been made from the 2019–2020 survey.[1]

Jurisdiction Validators

Senior medical imaging decision-makers within health ministries and/or regional health authority located in each province and territory were consulted to validate unit and exam counts for consistency. These validator-reported unit counts and examinations in the last fiscal year were preferentially used over survey data. Validator data were also used to calculate unit counts per population and exams per population.

Validators at times reported equipment dates that differed slightly from those documented the 2022–2023 CMII report. This often depended on the availability of regional- or provincial-level data at the time of reporting or for specific reporting periods. The site-level unit counts supplied by validators were used to identify missing or surplus units in the database.

Validators were also requested to identify:

- which health care professionals can order imaging exams for each of the different imaging modalities
- the sources of funding
- the drivers of jurisdictional decisions around replacing, upgrading, or adding new imaging equipment
- the criteria used when expanding imaging modalities into new geographic locations
- the approximate length of time it takes to review proposals for new equipment in sites
- the percentage of exams conducted in the private setting
- whether teleradiology services were used.

In some instances, validators also updated this provincial and/or regional data up until October 31, 2023.

Identification of Potential Respondents

Most respondents were identified in advance from a database of previous participants. These contacts were updated to account for changes due to position turnover, retirement, or restructuring.

Potential respondents included:

- individuals working in private or public health care settings that operate medical imaging equipment
- executive positions (e.g., the president of a private facility, a hospital administrator)
- leadership positions (e.g., a chief technologist, a manager or director of diagnostic imaging, a site coordinator).

Some respondents were identified through validators, external collaborators, and participant referrals. Respondents for new private facilities were identified by cross-referencing provincial documents, conducting web searches, and contacting facilities directly.

Passive methods of recruitment included promoting the renewed survey on the CADTH website and by word of mouth.

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

Duration of Survey

The survey opened on May 15, 2023, and data collection from survey respondents and validators was closed on October 31, 2023.

Data Validation

Once initial data collection from the survey was complete, we created summary statistics of the number of units per modality in each jurisdiction. The summary statistics were reviewed by the identified validators. Depending on the jurisdiction, each validator reviewed data for an entire province or territory, or for 1 or more health regions within a province. The validators assessed the summaries for accuracy and provided corrections and information on nonrespondents (e.g., unit counts or examinations, either at a site or jurisdictional level). The validators were also asked to encourage no-respondents in their regions to participate in the survey.

The validators provided unit counts and examination volume data for their jurisdiction (i.e., province or region). They were also given an early draft of the 2022−2023 CMII overview report and modality-specific reports to confirm the main findings. In some instances, validators adjusted site-level data.

Data Analysis

The data sources used in the CMII, with the exception of the survey and validator responses, are presented in Table 1. Use of the datasets in the analysis are presented in Table 2.

Table 1: Additional Data Sources Used in the CMII

Data source	Application of data
Canadian population data and projections	We obtained population data and projections for Canada and the provinces from Statistics Canada.[4]
International comparison data	We obtained international comparison data for the number of units and examinations for CT, MRI, and PET from the OECD website.[5-9]

CMII = Canadian Medical Imaging Inventory; OECD = Organisation for Economic Co-operation and Development.

Table 2: Use of Datasets in Analyses

Data summaries	Data sources							
	CMII 2022–2023 survey	CMII 2019–2020 survey	CMII 2017 survey[a,b]	CIHI 2012 data[c]	Validatior data[d]	Statistics Canada[e]	International data[f]	Other sources[g]
Summaries of site characteristics	x	x	x	—	—	—	—	—
Summaries of modality availability and number of units	x	x	x	—	x	—	—	—
Summary of planned installations and planned decommissioning	x	x	—	—	—	—	—	—
Summary of units at sites that had responses to the 2015 survey but no responses or validation data for the 2017 survey[a]	—	—	x	—	—	—	—	—
Maps of machine locations	x	—	—	—	—	—	—	—
Summaries of exams in 1 fiscal year	x	x	x	x	x	—	—	—
Summaries of average hours per week and hours per day of operation; summaries of proportions of types of use	x	x	x	—	—	—	—	—
Summaries of units per site and units per population	x	—	—	—	—	x	—	—
Comparisons of inventory with international availability for CT, MRI, and PET-CT	x	—	—	—	—	—	x	—
Age of units, current and decommissioned	x	x	x	x	—	—	—	—
Technical specifications of current units	x	x	x	x	—	—	—	—
Equipment decision-making considerations (e.g., funding source, equipment procurement, and expansion)	—	—	—	—	x	—	—	—

Data summaries	Data sources							
	CMII 2022–2023 survey	CMII 2019–2020 survey	CMII 2017 survey[a,b]	CIHI 2012 data[c]	Validatior data[d]	Statistics Canada[e]	International data[f]	Other sources[g]
Summaries related to health human resources and wait times	X	x	—	x	—	x	—	x

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; PET = positron emission tomography; x = data source used.

[a]Sites that had a response to the 2015 survey, but not the 2017 survey, identified by the lack 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.[2]

[c]From the dataset originally supplied to CADTH by CIHI, consisting of data collected between 2003 and 2012, as described in the 2015 CMII report.[2]

[d]Data were supplied by jurisdictional validators.

[e]International data from the OECD.[5-9]

[f]Population data from Statistics Canada.[4,10]

[g]Data were sourced from literature searches, research and professional organizations, and personal correspondence.

Data Summaries

We present the data using descriptive summaries and graphs of site-level and jurisdiction-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 (e.g., mean [average], median, or range between minimum and maximum values) or as assigned categories (e.g., hours of use per day as less than 8 hours, 8 to less than 12 hours, 12 to less than 18 hours, and 18 hours or more). Where we asked respondents to choose between 2 or more responses (e.g., yes or no), we report the counts and/or percentages of respondents who selected each response. Stacked bar charts were used to display the number of units and hours and percentage of use as categories. The geographical distribution of modalities was presented on maps using geocoded data.

International Comparison

The total or per capita number of units and exams of 3 imaging modalities — CT, MRI, and PET — from Organisation for Economic Co-operation and Development (OECD) countries was plotted with the data from the CMII 2022–2023 survey. Canada's ranking among OECD countries was reported.

Future Projections of the Numbers of Units and Exams for Canadian Provinces and Territories

The number of units and exams in Canada was projected for the years 2025, 2030, 2035, and 2040 based on the per capita values in 2022–2023 and estimated population growth provided by Statistics Canada.[10] Three different population scenarios were envisioned for low, medium, and high projected growth. Median units and exams were projected based on median growth and upper and lower limits were based on the high- and low-growth assumptions.

The projections calculations used the current per capita number of units and exams volumes for 2022–2023 and assumed that these values remained unchanged over the forested period.[11] The projections are based on jurisdiction-wide population data and did not reflect projected growth in specific areas within a jurisdiction. This simplified assumption was similar to the 1 made by the Conference Board of Canada.[11]

Missing Data and Imputation

Handling of Data From Sites Without Updated Data in 2022–2023

If the 2022–2023 survey was not updated for a site, we assumed there was no change from the 2019–2020 data. We carried forward data from previous surveys according to the following rules:

- Data for site characteristics, PACS use, unit and modality availability, exam counts, technical information, and use data collected during the CMII 2019–2020 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 before 2017 were not incorporated into data summaries unless they were confirmed in

2017 or later (e.g., for unit counts, by comparing with validators' data). Unconfirmed older data were set to missing.

Imputing Missing Data

- For most variables, summaries were prepared from observed cases only, with percentages calculated based on the total number of respondents.
- We imputed data for a limited number of missing values. 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%, 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."
- If the data source offered a year of installation but did not indicate the first year of operation, then the first year of operation was assumed to be the year following installation.

References

1. Chao Y-S, Sinclair A, Morrison A, Hafizi D, Pyke L. The Canadian Medical Imaging Inventory 2019-2020. Ottawa: CADTH; 2021: https://www.cadth.ca/sites/default/files/ou-tr/op0546-cmii3-final-report.pdf. Accessed 2024 Jan 10.

2. Sinclair A, Quay T, Pyke L, Morrison A. The Canadian Medical Imaging Inventory 2015. Ottawa: CADTH; 2016: https://www.cadth.ca/sites/default/files/pdf/canadian_medical_imaging_inventory_2015_e.pdf. Accessed 2024 Jan 10.

3. Sinclair A, Morrison A, Young C, Pyke L. Canadian Medical Imaging Inventory, 2017. Ottawa: CADTH; 2018: https://www.cadth.ca/sites/default/files/pdf/canadian_medical_imaging_inventory_2017.pdf. Accessed 2024 Jan 10.

4. Statistics Canada. Canada's population estimates, first quarter 2023. *The Daily*. Ottawa (ON): Government of Canada; 2023: https://www150.statcan.gc.ca/n1/daily-quotidien/230628/dq230628c-eng.htm. Accessed 2024 Jan 5.

5. Organisation for Economic Co-Operation and Development. Computed tomography (CT) scanners https://data.oecd.org/healtheqt/computed-tomography-ct-scanners.htm. Accessed 2023 Nov 9.

6. Organisation for Economic Co-Operation and Development. Magnetic resonance imaging (MRI) units. https://data.oecd.org/healtheqt/magnetic-resonance-imaging-mri-units.htm#indicator-chart. Accessed 2023 Nov 9.

7. Organisation for Economic Co-Operation and Development. Positron emission tomography (PET) scanners and exams. https://stats.oecd.org/ Accessed 2023 Nov 9.

8. Organisation for Economic Co-Operation and Development. Computed tomography (CT) exams. 2023; https://data.oecd.org/healthcare/computed-tomography-ct-exams.htm. Accessed 2023 Nov 9.

9. Organisation for Economic Co-Operation and Development. Magnetic resonance imaging (MRI) exams. 2023; https://data.oecd.org/healthcare/magnetic-resonance-imaging-mri-exams.htm#indicator-chart. Accessed 2023 Nov 9.

10. Canada S. Population Projections for Canada (2021 to 2068), Provinces and Territories (2021 to 2043): Technical Report on Methodology and Assumptions. 2023.

11. The value of radiology, part II. Ottawa: The Conference Board of Canada; 2019: https://car.ca/wp-content/uploads/2019/07/value-of-radiology-part-2-en.pdf. Accessed 2020 Sep 30.

Appendix 1: Survey Questions for the 2022–2023 CMII Survey

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. Those providing acute care are included.
  - 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 shorter 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
- How is this facility (i.e., a single hospital or a hospital campus site that is part of an amalgamation of hospitals) funded?
  - Public
  - Private
  - Both (please provide details)
- What is the estimated percentage of operating revenue sourced from out-of-pocket patient payments or private insurance? These data will be aggregated nationally and published in the CMII report at the national level. Please provide a number between 0 and 100:

Picture Archiving and Communication System (PACS)

- Are medical images stored on a picture archiving and communication system (PACS)?

    ◦ Yes

    ◦ No

    ◦ Don't know

- If yes, which imaging modalities use a PACS to store medical images? (Check all that apply.)

    ◦ CT

    ◦ MRI

    ◦ Single-photon emission CT (SPECT)

    ◦ PET or PET-CT

    ◦ PET-MRI

    ◦ SPECT-CT

- Is your PACS local, regional, or provincial, please specify?

    ◦ Local (institutional)

    ◦ Regional

    ◦ Provincial

    ◦ Don't know

- Do referring physicians have access to PACS images in areas of the hospital outside of diagnostic imaging (e.g., hospital clinics, the OR [operating room], case rounds meeting rooms, and so forth)?

    ◦ Yes

    ◦ No

    ◦ Don't know

- Are PACS images routinely accessible throughout your provincial or territorial health care system without the need to manually push images from any particular location or modality?

    ◦ Yes

    ◦ No

    ◦ Don't know

- If no, what are the barriers to accessing PACS images?

- Do you have a process for determining the appropriateness of orders that are received?

    ◦ Yes, for all exams

    ◦ Yes, for some exams

    ◦ No

    ◦ Don't know

- If yes, which process is used?
  - Radiologist review of requisition for appropriateness
  - Technologist review of requisition for appropriateness
  - Clinical decision support tool
  - Computer-aided order entry
  - Other (specify)
- Do you have the following fixed, mobile, or portable units at the site?
  - CT
  - MRI
  - SPECT
  - PET or PET
  - PET-MRI
  - SPECT-CT

Machine Types

- Do you have plans to install the following in the next 2 years?
  - CT
    - If yes, will these units be fixed/mobile or portable?
      - Fixed/mobile
      - Portable (A portable unit can be moved to a patient's bedside or used at the point of care.)
  - MRI
    - If yes, will these units be fixed/mobile or portable?
      - Fixed/mobile
      - Portable
  - SPECT
  - PET-CT or PET
  - PET-MRI
  - SPECT-CT

CT

CT: Make and Model

- What is the make of the CT unit?
  - Canon
  - GE
  - Hitachi

- - Philips
  - Siemens
  - Toshiba
  - Other
    - If "Other" is selected, please specify.
- What is the model of the CT unit?
- In what year did (or will) the CT unit become operational?
- Does this replace an existing unit?
  - Yes
  - No
  - Don't know
- If yes, what was the make of unit that was replaced?
- If yes, in what year was the old unit decommissioned?
- Has this unit been decommissioned?
  - Yes
  - No
  - Don't know
- If yes, in what year was it decommissioned?

CT: Individual Unit Specifications
- Is this CT unit new or previously used?
  - New
  - Previously used
- How many multi-detectors does the CT unit have (how many slices)?
  - 1, 2, 4, 6, 8, 16, 32, 40, 64, 128, 256, 264, 320, 384, 512, 640
  - Other
    - If "Other" is selected, please comment.
- 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 record patient radiation dose by exam (e.g., dose report on PACS)?
  - ○ Yes
  - ○ No
  - ○ Don't know
- Do you capture patient cumulative radiation dose tracking?
  - ○ Yes
  - ○ No
  - ○ Don't know
- If no, do you plan to capture patient cumulative radiation tracking in the future?
  - ○ Yes
  - ○ No
  - ○ Don't know
- Is the CT unit mobile? (Imaging equipment that travels to 2 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.
- Is this CT unit portable? (A portable unit can be moved to a patient's bedside or used at the point of care)
  - ○ Yes
  - ○ No
  - ○ Don't know
- If yes, please include the names of the departments that share the CT unit.

MRI

MRI: Make and Model

- What is the make of the MRI unit?
  - ○ Canon
  - ○ GE
  - ○ Hitachi
  - ○ Philips
  - ○ Siemens

- Toshiba
- Other
  - If "Other" is selected, please specify.
- What is the model of the MRI unit?
- In what year did (or will) the MRI unit become operational?
- Does this replace an existing unit?
  - Yes
  - No
  - Don't know
- If yes, what was the make of unit that was replaced?
- If yes, in what year was the old unit decommissioned?
- Has this unit been decommissioned?
  - Yes
  - No
  - Don't know
- If yes, in what year was it decommissioned?

MRI: Individual unit specifications

- Is this MRI unit new or previously used?
  - New
  - Previously used
- Is this MRI unit fixed/mobile or portable?
  - Fixed/mobile
  - Portable (Imaging equipment that travels to 2 or more communities to provide radiological services.)

MRI: Fixed/Mobile

- What is the field strength (tesla) of the MRI unit?
  - 1.5
  - 3
  - 5
  - 7
  - 9
  - 10
  - 11

- 15
- Other
    - If "Other" is selected, please comment.
- What is the configuration of the MRI unit?
    - Closed bore – normal (i.e., 60cm)
    - Closed bore – wide (i.e., 70cm)
    - Open bore
- Is the MRI unit mobile? (A portable unit can be moved to a patient's bedside or used at the point of care.)
    - Yes
    - No
    - Don't know
- If yes, please include the names of the sites that share the MRI unit.

MRI: Portable

- What is the make and model of the portable MRI unit?
    - Make:
        - Hyperfine
        - Other
    - Model:
        - Swoop
        - Other
    - If "Other" is selected, please specify the make and model:
- What is the field strength of this portable MRI unit in milli Tesla(mT)?
- Is this portable unit used for the following purposes?
    - Clinical
    - Research
    - Both

PET or PET–CT

PET or PET–CT: Make and Model

- What is the make of the PET or PET-CT unit?
    - Canon
    - GE
    - Hitachi

  - Philips
  - Siemens
  - Toshiba
  - Other
    - If "Other" is selected, please specify.
- What is the model of the PET or PET-CT unit?
- In what year did (or will) the PET or PET-CT unit become operational?
- Does this replace an existing unit?
  - Yes
  - No
  - Don't know
- If yes, what was the make of unit that was replaced?
- If yes, in what year was the old unit decommissioned?
- Has this unit been decommissioned?
  - Yes
  - No
  - Don't know
- If yes, in what year was it decommissioned?

PET or PET-CT: Individual Unit Specifications
- Is this PET or PET-CT unit new or previously used?
  - New
  - Previously used
- Is this a digital PET-CT unit?
  - Yes
  - No
  - Don't know
- Is this a dynamic whole-body PET-CT unit?
  - Yes
  - No
  - Don't know
- What is the imaging scope of the PET or PET-CT unit?
  - Head only
  - Near-whole body or 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, 384, 512, 640
  - Other
    - If "Other" is selected, please comment.
- Do you use the CT component of your PET-CT as a stand-alone CT unit for clinical CT examinations (i.e., to provide extra CT capacity)?
  - Yes
  - No
  - Don't know
  - Not applicable
- What is the PET or PET-CT axial field of view?
  - 15 to 19 cm
  - 20 to 24 cm
  - 25 to 29 cm
  - Other
    - If "Other" is selected, please comment.
- Does the PET or PET-CT unit have dose-management controls?
  - Yes
  - No
  - Don't know
- Does the PET or PET-CT unit record patient CT radiation dose (e.g., dose report on PACS)?
  - Yes
  - No
  - Don't know
- Do you capture patient cumulative radiation dose tracking?
  - Yes
  - No
  - Don't know
- If no, do you plan to capture patient cumulative radiation tracking in the future?
  - Yes
  - No
  - Don't know

- Is the PET or PET-CT unit mobile? (Imaging equipment that travels to 2 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 or PET-CT unit.

PET or PET–CT: Usage

- Does your facility (i.e., a single hospital or a hospital campus site that is part of an amalgamation of hospitals) operate a cyclotron for the PET or PET-CT units?
  - Yes
  - No
  - Don't know
- If yes, please describe the make and model of the cyclotron, whether it is single or dual beam, and the energy level or energy level range (MeV).
- Which radiotracers do you use for PET or PET-CT imaging?
  - Clinical purposes:
    - 18F-FDG
    - 11C-acetate
    - 11C-methionine
    - 68Ga-PSMA-HBED-CC
    - 18F-DCFPyL (BCCA, CPDC)
    - 18F-PSMA-1007
    - 18F-FACBC (Fluciclovine)
    - 18F-choline
    - 18F-FES
    - 18F-FET
    - 18F-FMISO
    - 68Ga-FAPI
    - 18F-FLT
    - 68Ga-DOTA-NOC
    - 68Ga-DOTA-TATE
    - 68Ga-DOTA-TOC
    - 64Cu-DOTA-DARA
    - 18F-NaF

- 15O-water
- 13N-ammonia
- 82Rb-chloride
- 18F-DOPA
- 18F-AV-45 (Florbetapir)
- [18F] Florbetaben
- [18F] Flutemetamol
- 18F-Pittsburgh compound B
- 11C HED (like MIBG)
- [11C] Raclopride
- [11C] Verapamil
- 18F-NaF (e.g., non-oncology bone scans)
- 18F-Fluorodeoxysorbitol (infectious or inflammatory imaging)
- For PET radiotracers not included above, please list below.
  - Research use:
    - 18F-FDG
    - 11C-acetate
    - 11C-methionine
    - 68Ga-PSMA-HBED-CC
    - 18F-DCFPyL (BCCA, CPDC)
    - 18F-PSMA-1007
    - 18F-FACBC (Fluciclovine)
    - 18F-choline
    - 18F-FES
    - 18F-FET
    - 18F-FMISO
    - 68Ga-FAPI
    - 18F-FLT
    - 68Ga-DOTA-NOC
    - 68Ga-DOTA-TATE
    - 68Ga-DOTA-TOC
    - 64Cu-DOTA-DARA
    - 18F-NaF

- 15O-water
- 13N-ammonia
- 82Rb-chloride
- 18F-DOPA
- 18F-AV-45 (Florbetapir)
- [18F] Florbetaben
- [18F] Flutemetamol
- 18F-Pittsburgh compound B
- 11C HED (like MIBG)
- [11C] Raclopride
- [11C] Verapamil
- 18F-NaF (e.g., non-oncology bone scans)
- 18F-Fluorodeoxysorbitol (infectious or inflammatory imaging)
- For PET radiotracers not included above, please list below.

- What is your percentage of clinical use for each radiotracer you use? The total percentage, expressed as a number, must add up to 100.
  - 18F-FDG
  - 11C-acetate
  - 11C-methionine
  - 68Ga-PSMA-HBED-CC
  - 18F-DCFPyL (BCCA, CPDC)
  - 18F-PSMA-1007
  - 18F-FACBC (Fluciclovine)
  - 18F-choline
  - 18F-FES
  - 18F-FET
  - 18F-FMISO
  - 68Ga-FAPI
  - 18F-FLT
  - 68Ga-DOTA-NOC
  - 68Ga-DOTA-TATE
  - 68Ga-DOTA-TOC
  - 64Cu-DOTA-DARA
  - 18F-NaF

- 15O-water
- 13N-ammonia
- 82Rb-chloride
- 18F-DOPA
- 18F-AV-45 (Florbetapir)
- [18F] Florbetaben
- [18F] Flutemetamol
- 18F-Pittsburgh compound B
- 11C HED (like MIBG)
- [11C] Raclopride
- [11C] Verapamil
- 18F-NaF (e.g., non-oncology bone scans)
- 18F-Fluorodeoxysorbitol (infectious or inflammatory imaging)
- For PET radiotracers not included above, please list below.

SPECT

SPECT: Make and Model

- What is the make of the SPECT unit?
  - Canon
  - GE
  - Hitachi
  - Philips
  - Siemens
  - Toshiba
  - Other
    - If "Other" is selected, please specify.
- What is the model of the SPECT unit?
- In what year did (or will) the SPECT unit become operational?
- Does this replace an existing unit?
  - Yes
  - No
  - Don't know
- If yes, what was the make of unit that was replaced?
- If yes, in what year was the old unit decommissioned?

- Has this unit been decommissioned?
  - Yes
  - No
  - Don't know
- If yes, in what year was it decommissioned?

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 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
  - Iterative reconstruction
- Is the SPECT unit mobile? (Imaging equipment that travels to 2 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.

SPECT–CT

SPECT–CT: Make and Model

- What is the make of the SPECT-CT unit?

  - ◦ Canon
  - ◦ GE
  - ◦ Hitachi
  - ◦ Philips
  - ◦ Siemens
  - ◦ Toshiba
  - ◦ Other
    - ▪ If "Other" is selected, please specify.
- What is the model of the SPECT-CT unit?
- In what year did (or will) the SPECT-CT unit become operational?
- Does this replace an existing unit?
  - ◦ Yes
  - ◦ No
  - ◦ Don't know
- If yes, what was the make of unit that was replaced?
- If yes, in what year was the old unit decommissioned?
- Has this unit been decommissioned?
  - ◦ Yes
  - ◦ No
  - ◦ Don't know
- If yes, in what year was it decommissioned?

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 multi-detectors does the SPECT-CT unit have (how many slices)?
  - ◦ 1, 2, 4, 6, 8, 16, 32, 40, 64, 128, 256, 264, 320, 384, 512, 640
  - ◦ 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
  - Iterative 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 record patient CT radiation dose (e.g., dose report on PACS)?
  - Yes
  - No
  - Don't know
- Do you capture patient cumulative radiation dose tracking?
  - Yes
  - No
  - Don't know
- If no, do you plan to capture patient cumulative radiation tracking in the future?
  - Yes
  - No
  - Don't know

- Is the SPECT-CT unit mobile? (Imaging equipment that travels to 2 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.

PET–MRI

PET–MRI: Make and Model
- What is the make of the PET-MRI unit?
  - Canon
  - GE
  - Hitachi
  - Philips
  - Siemens
  - Toshiba
  - Other
    - If "Other" is selected, please specify.
- What is the model of the PET-MRI unit?
- In what year did (or will) the PET-MRI unit become operational?
- Does this replace an existing unit?
  - Yes
  - No
  - Don't know
- If yes, what was the make of unit that was replaced?
- If yes, in what year was the old unit decommissioned?

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 or full body

- Is the PET-MRI unit mobile? (Imaging equipment that travels to 2 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.

All Modalities

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- How many full-time equivalents (FTE) technologists are assigned to all units (collective number of FTEs for all units at your site)?

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- For all units, how many examinations on average were conducted in the last fiscal year? (An imaging examination is defined as a single medical imaging session using an imaging modality to study 1 [or more than 1] body structure, body system, or anatomic area that yields 1 or more views for diagnostic and/or therapeutic purposes.)

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- In an average 168-hour week, how many hours are all units staffed through regular, scheduled service capacity? (Do not include hours where staff are only on call.)

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- In an average 24-hour day, how many hours are all units staffed through regular, scheduled service capacity? (Do not include hours where staff are only on call.)

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- Do any units operate on the weekend?
    - Yes
    - No
    - Don't know

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- Do any units operate 24 hours a day?
    - Yes
    - No
    - Don't know

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- Based on your practice in the last fiscal year, what percentage of time are all units used for? The total percentage, expressed as a number, must add up to 100.
  - Diagnostic purposes (cardiac only)
  - Diagnostic purposes (non-cardiac)
  - Interventional purposes
  - Research
  - Other (specify)

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- On average, what percentage of these exams fall into the following categories? The total percentage, expressed as a number, must add up to 100.
  - Oncology
  - Respiratory disease
  - Hepatobiliary or gastrointestinal
  - Musculoskeletal disorders
  - Inflammatory or infectious diseases
  - Neurologic
  - Cardiac
  - Trauma
  - Other (specify)

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- Are the units also used for radiation therapy treatment planning?
  - Yes
  - No
  - Don't know

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- Is a clinical decision support tool used at the point of care by medical professionals referring patients to medical imaging? (A clinical decision support tool provides real-time guidance to physicians on the appropriateness of diagnostic imaging tests for a given patient during the ordering process.)
  - Yes
  - No
  - Don't know

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- Is artificial intelligence used to support the following?
  - Reading/interpretation of images:
    - Yes
    - No
    - Don't know
  - If yes, in which setting is it used?
    - Clinical
    - Research
  - Please describe its use.
  - Predicting outcomes:
    - Yes
    - No
    - Don't know
  - If yes, in which setting is it used?
    - Clinical
    - Research
  - Please describe its use.
  - Lower radiation dose:
    - Yes
    - No
    - Don't know
  - If yes, in which setting is it used?
    - Clinical
    - Research
  - Please describe its use.
  - Image resolution/reconstruction enhancement
    - Yes
    - No
    - Don't know
  - If yes, in which setting is it used?
    - Clinical
    - Research

- ◦ Please describe its use.
- ◦ Treatment planning:
  - ▪ Yes
  - ▪ No
  - ▪ Don't know
- ◦ If yes, in which setting is it used?
  - ▪ Clinical
  - ▪ Research
- ◦ Please describe its use.
- ◦ Administrative tasks:
  - ▪ Yes
  - ▪ No
  - ▪ Don't know
- ◦ If yes, in which setting is it used?
  - ▪ Clinical
  - ▪ Research
- ◦ Please describe its use.

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- • Do radiologists at your facility participate in a peer review/learning program for image reading and interpretation for the purpose of quality assurance?
  - ◦ Yes
  - ◦ No
  - ◦ Don't know

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- • Are automated order entry forms (exams requests) used?
  - ◦ Yes
  - ◦ No
- • Are electronic referrals used?
  - ◦ Yes
  - ◦ No
- • Are paper forms (exams requests) used?
  - ◦ Yes
  - ◦ No

- Are requests received by fax?
  - Yes
  - No
- Are requests received by phone?
  - Yes
  - No

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- Is a centralized order entry (booking) system used?
- For all exams:
  - Yes
  - No
- For some exams:
  - Yes
  - No

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- How is imaging equipment serviced?
  - Under warranty
  - Full vendor service contract
  - Shared service (between vendor and in-house or a third party)
  - Third party
  - À la carte (time and parts by external service provider)
  - Insurance
  - Managed equipment service
  - Other

This applies to: CT, MRI, PET or PET-CT, SPECT, SPECT-CT, PET-MRI

- How much planned downtime is anticipated for scheduled maintenance for all units in a given year (expressed in hours)?
- How much unplanned downtime is experienced for all units in a given year (expressed in hours)?
- Please describe the reasons for unplanned downtime.
- Do you have a system or process to record unplanned downtime for all units?
  - Yes
  - No

- Don't know
- Do you review guaranteed uptime for accountability purposes?
  - Yes
  - No
  - Don't know