

# **Publicly Funded Uses of PET Scans in Canada**

## **Context**

Positron emission tomography (PET) is a nuclear medical imaging tool. PET scanners require a cyclotron or a positron emitter generator to manufacture the isotopes that are used in PET scans.<sup>1</sup> PET represents a nuclear imaging alternative to single photon emission computed tomography (SPECT).<sup>1</sup> Both technologies provide images of the structure and function of tissues and organs.

Most PET scanners are equipped with a computed tomography (CT) scanner, which allows for detection of physiological changes (via PET) and anatomic changes (via CT) simultaneously.<sup>2</sup> Hybrid PET/magnetic resonance imaging (MRI) scanners provide additional detail on soft-tissues and may be more clinically relevant for head and neck cancers, and neoplasms in the pelvis and abdomen.<sup>3</sup> Due to its lower ionizing radiation dose, in comparison to PET/CT, PET/MRI may also be useful for pediatric patients and for pregnant women.<sup>3</sup> Both PET/CT and PET/MRI availability in Canada is mostly limited to facilities in large urban centres.<sup>1</sup> This Environmental Scan uses the term PET to refer to all PET modalities, including PET/CT and PET/MRI, unless otherwise specified.

The 2007 and 2009 shortages of Technetium-99m ( $^{99m}\text{Tc}$ ), the medical isotope used in SPECT scans, mobilized the medical community to look for alternative imaging techniques.<sup>4</sup> More recently, it was announced that the National Research Universal reactor in Chalk River, which produces medical isotopes, will stop production in 2018.<sup>5</sup> In 2009, the Government of Canada appointed an independent Expert Review Panel on Medical Isotope Production to assess more reliable ways of supplying isotopes. Amongst its recommendations, the Panel suggested that the government invest in PET to reduce demand for  $^{99m}\text{Tc}$  over the short- and long-term.<sup>4</sup> The government responded by confirming its support to the continued diversification of advanced medical imaging technologies, including PET.<sup>6</sup> This report provides an update on the availability of PET scanning services in Canada.

## **Objectives**

This Environmental Scan is an update to two previous CADTH reports from 2010<sup>7</sup> and 2011.<sup>8</sup> The objective of this report is to identify and summarize information regarding the use of PET across Canada. The following questions are addressed:

1. How many publicly and privately funded PET scanners and cyclotrons are there in each Canadian jurisdiction?
2. How many PET scans are funded each year by each jurisdiction?
3. What are the approved publicly funded indications for PET in each jurisdiction?

## **Methods**

The findings of this report are based on responses to the CADTH Positron Emission Tomography in Canada 2015 survey. Survey respondents were asked to update and complete data tables from the 2011<sup>8</sup> (Table 1) and 2010<sup>7</sup> (Table 2) reports according to their jurisdiction. The survey was sent to key informants from organizations and health authorities specializing in medical imaging in jurisdictions across Canada. Survey data were gathered until September 16, 2015. In addition, a limited search of the grey literature was performed as of July 28, 2015.

## **Findings**

Surveys were distributed to contacts in all 10 provinces. There are no PET scanners in the territories, thus surveys were not sent to these jurisdictions. Survey responses were received from informants in Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, and Saskatchewan (one response per province) (Appendix 1).

### **Publicly Funded PET Scanning Services and Number of Funded Annual Scans**

As of September 2015, there are 43 publicly funded PET scanners in Canada, operational in 33 centres (see Table 1). This includes 37 PET/CT, four PET, and two PET/MRI scanners. Two of these scanners are located in British Columbia, four in Alberta, one in Saskatchewan, one in Manitoba, 16 in Ontario, two in New Brunswick, and one in Nova Scotia. Newfoundland anticipates a PET/CT scanner to be operational in 2016. Based on data from the 2011 report,<sup>8</sup> there are 16 PET scanners in Quebec. Since the 2011 report,<sup>8</sup> PET scanning and cyclotron capacity in Canada has generally increased (Table 1). In Canada, 62,668 PET scans were performed in 2011-2012, and over 98% of these were conducted in hospital settings.<sup>9</sup>

According to the respondent from British Columbia, the province has two PET scanners located at the Vancouver BC Cancer Agency. There are two cyclotrons in operation; one used principally for research, while the other is used for both research and clinical purposes. The province of British Columbia is funded to perform 7,775 PET/CT scans per year.

Alberta has four PET/CT scanners, located in three facilities (two facilities in Edmonton and one facility in Calgary). The Cross Cancer Institute in Edmonton has a cyclotron, in addition to a PET/CT scanner. In 2009, Alberta funded 5,500 PET scans.<sup>2</sup>

Saskatchewan has one PET/CT scanner located in Saskatoon, and one cyclotron will be tentatively operational in 2016. The number of publicly funded annual scans is uncertain.

Manitoba has one PET/CT scanner, and one cyclotron, located in Winnipeg. According to the Manitoba respondent, the province funds 2,000 scans per year.

Ontario has 16 PET scanners at 10 centres. There is one PET scanner in Hamilton, one PET/CT scanner in Hamilton, three PET/CT scanners in Ottawa, one PET scanner in Toronto, six PET/CT scanners in Toronto, one PET/MRI scanner in Toronto, one PET/CT scanner in London, one PET/MRI scanner in London, and one PET/CT scanner in Thunder Bay. The Royal Ottawa Mental Health Centre is also anticipating the addition of one PET/MRI scanner, to be used for research purposes only. Ontario is home to eight cyclotrons: one in Hamilton, one in Ottawa, four in Toronto, one in London, and one in Thunder Bay. In 2014, Ontario funded 11,081 PET scans.

Quebec has 12 PET scanners at 11 major hospitals, and the remaining 4 PET/CT scanners at smaller centres. Two PET scanners and six PET/CT scanners are located in Montreal; one cyclotron is also located in Montreal. There is one PET/CT scanner in each of the following cities: Quebec City, Gatineau, Laval, Trois-Rivières, Rimouski, and Chicoutimi. Two PET/CT

scanners are located in Sherbrooke. There are two cyclotrons in Quebec, one in Montreal and one in Sherbrooke. In 2009, Quebec performed 22,400 scans.<sup>2</sup>

There are two PET/CT scanners in New Brunswick; one is located in Saint John and one is located in Moncton. Approximately 1,340 scans were performed in New Brunswick in 2014-2015 according to the respondent from this province.

According to the survey response, Newfoundland and Labrador are planning to have an operational cyclotron and PET/CT scanner in 2016. In 2009, there were 100 scans funded; patients were sent out-of-province for PET scans.<sup>2</sup>

Nova Scotia has one cyclotron and one PET/CT scanner, which are located in Halifax. In 2009, there were 1,600 scans performed at the facility in Halifax, and approximately 1,500 were funded by Nova Scotia, as a small number of these patients were from out-of-province.<sup>2</sup>

Prince Edward Island currently does not have PET scanners or a cyclotron. In 2014-2015, 104 patients were sent out of province to have scans, according to the respondent from PEI. The Northwest Territories, Nunavut and the Yukon do not have PET scanners, and patients must be sent out of territory to have scans.<sup>7</sup>

<b>Table 1: Location of Publicly Funded PET Scanners and Cyclotrons in Canada (2015)</b>					
<b>Province</b>	<b>Hospital or Centre</b>	<b>City</b>	<b>Type (Number of Scanners)</b>	<b>Number of PET Cyclotrons</b>	<b>Additional Information</b>
British Columbia	BC Cancer Agency	Vancouver	PET/CT (2)	1	For clinical and research use
	UBC	Vancouver	N/A	1	TRIUMF cyclotron operates principally for research
Alberta	Cross Cancer Institute	Edmonton	PET/CT (1)	1	
	University of Alberta Hospital	Edmonton	PET/CT (1)		
	Foothills Hospital	Calgary	PET/CT (2)		
Saskatchewan	Royal University Hospital	Saskatoon	PET/CT (1)	1	Cyclotron on University of Saskatchewan campus anticipated to be operational in 2016
Manitoba	Health Sciences Centre	Winnipeg	PET/CT (1)	1	
Ontario	Hamilton Health Sciences	Hamilton	PET (1)	1	
	St. Joseph's Healthcare Hamilton	Hamilton	PET/CT (1)		
	The Ottawa Hospital	Ottawa	PET/CT (1)		
	University of Ottawa Heart Institute	Ottawa	PET/CT (2)	1	

**Table 1: Location of Publicly Funded PET Scanners and Cyclotrons in Canada (2015)**

Province	Hospital or Centre	City	Type (Number of Scanners)	Number of PET Cyclotrons	Additional Information
Ontario	Centre for Addiction and Mental Health	Toronto	PET (1) PET/CT (1) (both scanners used for brain research only)	2 (1 used for research only)	
	University Health Network	Toronto	PET/CT (3) (1 used for research only)  PET/MR (1) (research only)	1 (research only)	
	Sunnybrook Health Sciences Centre	Toronto	PET/CT (1)	1	1 PET/MRI scanner is upcoming; it will be used for research only
	Hospital for Sick Children	Toronto	PET/CT (1)		
	St. Joseph's Health Care	London	PET/CT (1)  PET/MRI (1) (research only)	1	
	Thunder Bay Regional Health Sciences Centre	Thunder Bay	PET/CT (1)	1	Cyclotron (installed in 2015) is not yet producing PET isotopes for human use
Quebec*	McGill University Health Centre (Montreal General Hospital)	Montreal	PET/CT (1)		
	Montreal Neurological Institute and Hospital	Montreal	PET (2)	1	Used for research purposes
	Hôpital Notre Dame	Montreal	PET/CT (1)		Used for research purposes
	Hôtel-Dieu de Montréal (Centre hospitalier de l'Université de Montréal)	Montreal	PET/CT (1)		
	Jewish General Hospital	Montreal	PET/CT (1)		

Table 1: Location of Publicly Funded PET Scanners and Cyclotrons in Canada (2015)					
Province	Hospital or Centre	City	Type (Number of Scanners)	Number of PET Cyclotrons	Additional Information
Quebec	Hôpital Maisonneuve-Rosemont	Montreal	PET/CT (1)		
	CHU Sainte-Justine Hospital	Montreal	PET/CT (1)		
	L'Hôtel-Dieu de Québec (Centre hospitalier universitaire de Québec)	Quebec City	PET/CT (1)		
	Université de Sherbrooke Hospital	Sherbrooke	PET/CT (2)	1	Current cyclotron operates principally for research and commercial 18F production
	Hôpital Laval	Laval	PET/CT (1)		
	Centre hospitalier régional de Trois-Rivières	Trois-Rivières	PET/CT (1)		
	Centre de santé et de services sociaux de Rimouski-Neigette	Rimouski	PET/CT (1)		
	Centre de santé et de services sociaux de Chicoutimi	Chicoutimi	PET/CT (1)		
	Centre de santé et de services sociaux de Gatineau	Gatineau	PET/CT (1)		
	Saint John Regional Hospital	Saint John	PET/CT (1)		
New Brunswick	Dr. Georges-L.-Dumont University Hospital Centre	Moncton	PET/CT (1)		
	Newfoundland and Labrador	Health Sciences Centre	St John's		Cyclotron and PET/CT anticipated to be operational in 2016
Nova Scotia	Nova Scotia Health Authority Queen Elizabeth II Health Sciences	Halifax	PET/CT (1)	1	

\*Information is current as of the previous CADTH report from 2011<sup>8</sup>

18-F = florpiramidine; CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography; TRIUMF = Canada's National Laboratory for Particle and Nuclear Physics; UBC = University of British Columbia

## Privately Funded PET Scanning Services

According to the surveys and published information<sup>2</sup>, there are seven privately funded PET scanning facilities in addition to the 43 publicly funded PET scanners in Canada. British Columbia has one privately funded PET/CT scanner, located in Burnaby.<sup>2</sup> Three privately funded scanners are in Ontario; Mississauga has two PET/CT scanners and Windsor is home to one PET/CT scanner. There are three facilities with privately funded PET scanners in Quebec; Montreal has one PET scanner and one PET/CT scanner, and Quebec City has one PET/CT scanner.<sup>2</sup>

## Publicly Funded Indications for PET Scanners

A primary indication for publicly funded PET scanning services is oncology, where PET scanning can be used for diagnosis, staging, and detection of disease.<sup>2</sup> Oncology indications include lung, breast, solitary pulmonary nodule, head and neck, and esophageal cancers. PET scanners are also used for cardiac imaging (such as myocardial viability assessment) and neurological imaging (such as in patients with dementia). Table 2 provides detailed information on the publicly funded indications for PET scanning in each jurisdiction.

**Table 2: Publicly Funded Applications of PET Scans**

Indication	BC	AB	SK	MB	ON	QC <sup>a</sup>	NB	NL	PE	NS
<b>Cancer</b>										
Solitary pulmonary nodule	☒	☒			☒	☒	☒	☒	☒	☒
Lung		Non-small cell	☒		☒	Non-small cell	☒	☒	☒	☒
					☒	Limited disease small cell	☒	☒	☒	☒
Head and neck	☒	☒			☒	☒	☒	☒	☒	☒
Esophageal	☒	☒			☒	☒	☒	☒	☒	☒
Breast Cancer	☒	☒			☒	Upcoming trial	☒	☒	☒	☒
Germ cell tumours	☒	☒			☒	☒	*	□	□	☒
Colorectal	☒	☒			☒	☒	☒	☒	☒	☒
Lymphoma	☒	☒			☒	☒	☒	☒	☒	☒
Melanoma	☒	☒			☒	☒	☒	☒	☒	☒
Myeloma <sup>a</sup>	□	☒			☒	□	*	□	□	□
Thyroid	☒	☒			☒	☒	*	☒	☒	☒
Testicular	☒	☒			☒	☒	☒	☒	□	☒
Gynecologic	☒	☒			☒	□	☒	☒	□	☒
Occult	□	☒			☒	☒	*	□	□	☒
Sarcoma	☒	☒			☒	Pediatric only	☒	□	□	☒
Brain	☒	☒			☒	Pediatric only	□	☒	□	□
Neuroblastoma	Pediatric only	□			☒	Pediatric only	*	□	□	☒
Pancreatic	□	☒			☒	Pediatric only	*	□	□	☒
Neuroendocrine	□	☒			☒	□	*	☒	□	☒
Musculoskeletal	□	☒			☒	□	**	☒	□	☒

Evaluated for approval by the Ministry's Medical consultants on a case by case basis

Evaluated for approval by request from internist, respirologist, or oncologist based on clinical indications

**Table 2: Publicly Funded Applications of PET Scans**

Indication	BC	AB	SK	MB	ON	QC <sup>a</sup>	NB	NL	PE	NS
Gall Bladder	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	*	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Gastric	<input type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input type="checkbox"/>	*	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input checked="" type="checkbox"/>
Kidney	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>	Pediatric only	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input checked="" type="checkbox"/>
Liver	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	Pediatric only	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
Bladder	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
Other	Case by case	<input type="checkbox"/>		<input checked="" type="checkbox"/>	Case by case	<input type="checkbox"/>	<input type="checkbox"/>	Case by case		Case by case
<b>Cardiology</b>										
Myocardial viability assessment	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	See above	<input type="checkbox"/>
Myocardial perfusion assessment	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
Sarcoidosis	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>						
Other					Case by case					
<b>Neurology</b>										
Refractory seizure	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Upcoming	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	See above	<input checked="" type="checkbox"/>
Radionecrosis	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
Dementia	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Case by case	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
<b>Other</b>										
Lymphadenopathy	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	See above	<input checked="" type="checkbox"/>

<sup>a</sup>Based on data from the CADTH 2010 report<sup>7</sup>

\*Performed when specific conditions are met (when other imaging modalities failed to characterize a lesion, to exclude unsuspected metastatic disease, or when clinical information is required)

\*\*Funded in Quebec during isotope shortage

## Limitations

The findings of this Environmental Scan present an overview of PET usage across Canada, and is based on a limited search of the grey literature and survey responses from nine jurisdictions. Therefore, the findings may not provide a complete representation of all Canadian jurisdictions.

In the 2011 report,<sup>8</sup> several anticipated PET scanners and cyclotrons were identified for Quebec, however, no update was available to confirm the status of these units. Additionally, current data on the number of funded annual scans per province was unavailable for some jurisdictions.

## Conclusion

There are approximately 33 centres performing publicly funded PET scans in eight Canadian provinces. There are 43 publicly funded PET scanners currently in operation in Canada.

Additionally, seven facilities perform privately funded PET scans in Canada, three of which are in the province of Quebec, three in Ontario, and one in British Columbia. In Canada, 62,668 PET scans were performed in 2011-2012, and over 98% of these were conducted in hospital settings.<sup>9</sup> The most popular application of PET across Canada is for oncology, and it is also used for cardiac and neurological imaging.

## References

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## **Appendix 1: Information on Survey Respondents**

<b>Province</b>	<b>Organization represented by survey respondents</b>
<b>Alberta</b>	Alberta Health Services
<b>British Columbia</b>	BC Cancer Agency
<b>Manitoba</b>	Health Sciences Centre (Winnipeg Regional Health Authority)
<b>New Brunswick</b>	Department of Health
<b>Newfoundland</b>	Health and Community Services
<b>Nova Scotia</b>	Nova Scotia Health Authority
<b>Ontario</b>	Cancer Care Ontario
<b>Prince Edward Island</b>	Health PEI
<b>Saskatchewan</b>	Saskatoon Health Region

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