

Rapid Synthesis

Examining the Public Provision and Funding of PET-CT Imaging for Non-cancer Indications

15 February 2018



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Rapid Synthesis:
Examining the Public Provision and Funding of PET-CT Imaging for Non-cancer Indications
30-day response

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McMaster Health Forum

The McMaster Health Forum's goal is to generate action on the pressing health-system issues of our time, based on the best available research evidence and systematically elicited citizen values and stakeholder insights. We aim to strengthen health systems – locally, nationally, and internationally – and get the right programs, services and drugs to the people who need them.

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Timeline

Rapid syntheses can be requested in a three-, 10- or 30-business-day timeframe. This synthesis was prepared over a 30-business-day timeframe. An overview of what can be provided and what cannot be provided in each of the different timelines is provided on McMaster Health Forum's Rapid Response program webpage (www.mcmasterforum.org/find-evidence/rapid-response).

Funding

The rapid-response program through which this synthesis was prepared is funded by the Government of British Columbia. The McMaster Health Forum receives both financial and in-kind support from McMaster University. The views expressed in the rapid synthesis are the views of the authors and should not be taken to represent the views of the Government of British Columbia or McMaster University.

Conflict of interest

The authors declare that they have no professional or commercial interests relevant to the rapid synthesis. The funder played no role in the identification, selection, assessment, synthesis or presentation of the research evidence profiled in the rapid synthesis.

Merit review

The rapid synthesis was reviewed by a small number of policymakers, stakeholders and researchers in order to ensure its scientific rigour and system relevance.

Acknowledgments

The authors wish to thank Eilish Scallan for assistance with identifying, reviewing and synthesizing literature. We are especially grateful to Andra Morrison for her insightful comments and suggestions.

Citation

Mattison CA, Gauvin FP, Wilson MG. Rapid synthesis: Examining the public provision and funding of PET-CT imaging for non-cancer indications. Hamilton, Canada: McMaster Health Forum, 15 February 2018.

Product registration numbers

ISSN 2292-7999 (online)

KEY MESSAGES

- For what non-cancer indications have Canadian and Organisation for Economic Cooperation and Development (OECD) health systems included PET-CT in packages of care, and what payment models are used to support its delivery?

Why the issue is important

- Positron emission tomography–computed tomography (better known as PET-CT) has revolutionized medical diagnosis.
- While PET-CT scanners have been predominantly used in oncology, they are now increasingly used in various disciplines such as general internal medicine, infectiology, cardiology, neurology, surgery, traumatology, orthopedics, pediatrics, endocrinology, rheumatology, psychiatry, neuropsychology and cognitive neuroscience.
- Since PET-CT scanners hold significant promise in transforming the management of patients with a range of conditions, many jurisdictions have begun to expand the publicly funded indications for PET-CTs to include many non-cancer indications.
- In response to increases in indications used in PET-CT imaging, this rapid synthesis aims to identify for what non-cancer indications Canadian and OECD health systems have included PET-CT in packages of care, and what payment models are used to support its delivery.

What we found

- We undertook a scan of 18 comparator jurisdictions (each Canadian province, Australia, Belgium, France, Ireland, New Zealand, Spain, Switzerland and the United Kingdom) to identify for what non-cancer indications PET-CT has been included in packages of care, and what payment models are used to support its delivery.
- There is great variability across Canadian provinces in terms of access to and criteria for PET-CT imaging for non-cancer indications.
- Three provinces do not provide PET-CTs for non-cancer indications (British Columbia, New Brunswick and Newfoundland and Labrador), and Prince Edward Island does not have a PET-CT unit (out-of-province imaging can be requested based on the clinical indication).
- Of the provinces that provide PET-CT imaging for non-cancer indications, the most common are cardiology-related (e.g., myocardial viability assessment) and neurology-related (e.g., epilepsy/refractory seizure or dementia).
- In Canada, Quebec emerged as a leader both in access to and funding of PET-CT services for non-cancer indications.
- With the exception of Spain, all of the select comparator jurisdictions provide publicly funded PET-CTs for non-cancer indications to varying degrees.
- Across all jurisdictions, the primary location of PET-CT units is in hospitals, and referral to PET-CT imaging is through a healthcare professional, most often a specialist.
- Information regarding how PET-CTs for non-cancer indications are funded was difficult to access, and many times the data was not publicly available.
- In Canada, with the exception of Quebec and Ontario, we were unable to determine how PET-CTs are funded for non-cancer indications based on the available information.
- Within the select comparator countries, PET-CTs for the listed non-cancer indications are paid for through public insurance plans.

QUESTION

For what non-cancer indications have Canadian and Organisation for Economic Cooperation and Development (OECD) health systems included PET-CT in packages of care, and what payment models are used to support its delivery?

WHY THE ISSUE IS IMPORTANT

Positron emission tomography–computed tomography (better known as PET-CT) has revolutionized medical diagnosis since the first commercial systems reached the market in the early 2000s.(1) This advanced nuclear imaging technique combines a positron emission tomography (PET) scanner and an X-ray computed tomography (CT) scanner into a single machine. PET-CTs create three-dimensional images, providing information about both the structure and function of cells and tissues in the body during a single imaging session.(1)

PET-CTs have been predominantly used in oncology to diagnose and stage different types of cancers.(2) They allow for the whole body to be imaged, which has practical applications in tracking both tumour spread and recurrence.(2) Over the last decade, however, clinical applications of PET-CTs have expanded beyond cancer-related indications. PET-CTs are increasingly being used in a variety of disciplines including general internal medicine, infectiology, cardiology, neurology, surgery, traumatology, orthopedics, pediatrics, endocrinology, rheumatology, psychiatry, neuropsychology and cognitive neuroscience.(3)

In Canada, the Canadian Institute for Health Information historically collected data on medical imaging technologies. In 2012, the Canadian Agency for Drugs and Technologies in Health assumed the role of maintaining the inventory (Canadian Medical Imaging Inventory) and publishing findings biannually.(2) The most recent report was released in 2016 and the next cycle is due for release in the spring of 2018. An environmental scan conducted by the Canadian Agency for Drugs and Technologies in Health in 2015 revealed that the most common application of PET-CTs was for oncology-related indications.(4) The use of PET-CTs has been approved for specific clinical indications in both adult and pediatric oncology patients.(5) In British Columbia, PET-CTs are only conducted for cancer-related indications, which is why the Ministry of Health of British Columbia has requested this rapid synthesis.

There are approximately 45 publicly funded PET-CTs in Canada. Table 1 presents a breakdown of the location and number of PET-CT units.(2; 4; 6-8) It is estimated that a total of 90,530 PET-CT exams were performed in 2017, which translates to two exams per 1,000 people.(2; 9) Quebec and New Brunswick have the highest number of PET-CT units per population, while British Columbia and Manitoba have the

Box 1: Background to the rapid synthesis

This rapid synthesis mobilizes both global and local research evidence about a question submitted to the McMaster Health Forum's Rapid Response program. Whenever possible, the rapid synthesis summarizes research evidence drawn from systematic reviews of the research literature and occasionally from single research studies. A systematic review is a summary of studies addressing a clearly formulated question that uses systematic and explicit methods to identify, select and appraise research studies, and to synthesize data from the included studies. The rapid synthesis does not contain recommendations, which would have required the authors to make judgments based on their personal values and preferences.

Rapid syntheses can be requested in a three-, 10- or 30-business-day timeframe. An overview of what can be provided and what cannot be provided in each of these timelines is provided on the McMaster Health Forum's Rapid Response program webpage (www.mcmasterforum.org/find-evidence/rapid-response)

This rapid synthesis was prepared over a 30-business-day timeframe and involved four steps:

- 1) submission of a question from a policymaker or stakeholder (in this case, the Ministry of Health of British Columbia);
- 2) conducting a jurisdictional scan about the question;
- 3) drafting the rapid synthesis in such a way as to present concisely and in accessible language the research evidence; and
- 4) finalizing the rapid synthesis based on the input of at least two merit reviewers.

lowest.(2) The median operating hours for PET-CTs in Canada is 40 hours per week (eight hours per day).(2) While PET-CTs are primarily used for clinical and diagnostic purposes in Canada, there is a larger proportion of PET-CTs dedicated to research when compared to other medical imaging units (e.g., computed tomography and magnetic resonance imaging).(2)

Although PET-CTs are most commonly used for cancer-related indications, many jurisdictions have recognized their role in diagnosing neurological, cardiovascular, infectious and inflammatory pathologies.(2) As a response to this, some jurisdictions have expanded the publicly funded indications for PET-CTs to include many non-cancer indications. The rapid synthesis seeks to address this by:

- 1) identifying what non-cancer indications Canadian and OECD health systems have included in PET-CT packages of care; and
- 2) what payment models are used to support its delivery.

Table 1: Number and location of publicly funded PET-CTs in Canada

Jurisdiction	Number of PET-CTs	Location
British Columbia	2	<ul style="list-style-type: none"> • Vancouver <ul style="list-style-type: none"> ○ BC Cancer Agency ○ University of British Columbia
Alberta	4	<ul style="list-style-type: none"> • Calgary <ul style="list-style-type: none"> ○ Foothills Medical Centre (2) • Edmonton <ul style="list-style-type: none"> ○ Cross Cancer Institute ○ University of Alberta Hospital
Saskatchewan	1	<ul style="list-style-type: none"> • Saskatoon <ul style="list-style-type: none"> ○ Royal University Hospital
Manitoba	1	<ul style="list-style-type: none"> • Winnipeg <ul style="list-style-type: none"> ○ Health Sciences Centre
Ontario	15	<ul style="list-style-type: none"> • Hamilton <ul style="list-style-type: none"> ○ St. Joseph's Healthcare Hamilton ○ Hamilton Health Sciences • London <ul style="list-style-type: none"> ○ St. Joseph's Health Care London • Ottawa <ul style="list-style-type: none"> ○ Ottawa Heart Institute ○ The Ottawa Hospital ○ Royal Mental Health Centre ○ University of Ottawa Heart Institute (2) • Thunder Bay <ul style="list-style-type: none"> ○ Thunder Bay Regional Health Sciences Centre • Toronto <ul style="list-style-type: none"> ○ Centre for Addiction and Mental Health ○ SickKids ○ Sunnybrook Health Sciences Centre ○ University Health Network (3)

Quebec	18	<ul style="list-style-type: none"> • Chicoutimi <ul style="list-style-type: none"> ○ Centre de santé et de services sociaux de Chicoutimi • Gatineau <ul style="list-style-type: none"> ○ Centre de santé et de services sociaux de Gatineau • Quebec City <ul style="list-style-type: none"> ○ Institut universitaire de cardiologie et de pneumologie de Québec ○ L'Hôtel-Dieu de Québec (Centre hospitalier universitaire de Québec) • Laval <ul style="list-style-type: none"> ○ Hôpital de la Cité-de- la-Santé • Lévis <ul style="list-style-type: none"> ○ Hôtel-Dieu de Lévis • Montreal <ul style="list-style-type: none"> ○ CHU Sainte-Justine Hospital ○ Hôpital Maisonneuve- Rosemont ○ Hôpital Neurologique de Montréal (McGill University Health Centre) ○ Hôpital Notre Dame ○ Hôtel-Dieu de Montréal (Centre hospitalier de l'Université de Montréal) ○ Institut de Cardiologie de Montréal (l'Université de Montréal) (2) ○ Jewish General Hospital • Rimouski <ul style="list-style-type: none"> ○ Centre de santé et de services sociaux de Rimouski-Neigette ○ Hôpital Régional de Rimouski • Sherbrooke <ul style="list-style-type: none"> ○ CHUS-Centre hospitalier universitaire de Sherbrooke • Trois-Rivières <ul style="list-style-type: none"> ○ Centre hospitalier régional de Trois- Rivières
New Brunswick	2	<ul style="list-style-type: none"> • Moncton <ul style="list-style-type: none"> ○ Dr. Georges-L.- Dumont University Hospital Centre • Saint John <ul style="list-style-type: none"> ○ Saint John Regional Hospital
Newfoundland and Labrador	1	<ul style="list-style-type: none"> • St John's <ul style="list-style-type: none"> ○ Eastern Health
Nova Scotia	1	<ul style="list-style-type: none"> • Halifax <ul style="list-style-type: none"> ○ Nova Scotia Health Authority QE II Health Sciences Centre
Total	45	

Sources: (2; 4; 6; 9)

WHAT WE FOUND

We undertook a scan of 18 comparator jurisdictions that were pre-determined by the requestor, with the search strategy detailed in Box 2. The comparator jurisdictions included each of the 10 Canadian provinces, Australia, Belgium, France, Ireland, New Zealand, Spain, Switzerland, and the United Kingdom. For these jurisdictions we identified (where possible) for what non-cancer indications PET-CT has been included in packages of care, and what payment models are used to support its delivery. To conduct the scan, we purposefully sampled websites from each of the jurisdictions. This included reviewing the websites of the government agency responsible for health, key agencies or organizations involved in providing insurance for or delivering PET-CT imaging services, as well as key agencies or organizations responsible for health-technology assessment and clinical-practice guidelines.

We classified non-cancer indications using the same broad categories used by the Canadian Agency for Drugs and Technologies in Health's Canadian Medical Imaging Inventory:

- cardiology;
- inflammatory (includes infections); and
- neurology.

In addition to the three categories, we included 'other' to capture those indications that did not fall within the classifications.

We provide a summary of the results of the jurisdictional scan in Table 2 in terms of:

- 1) the specific non-cancer indications for PET-CTs, which are grouped within the three broad categories (cardiology, inflammatory and neurology);
- 2) how PET-CTs are delivered for non-cancer indications (e.g., where PET-CTs are delivered and how they are accessed); and
- 3) how PET-CTs are publicly funded (e.g., global budgets).

Given that our scan consisted of a purposeful sampling of key websites in each jurisdiction (as described above), Table 2 may not provide a comprehensive overview of PET-CTs for non-cancer indications, but rather a broad outline of key characteristics. This was particularly relevant to information regarding how PET-CTs for non-cancer indications are funded. This type of information was difficult to access, and many times the data was not publicly available. In addition, in the reviews conducted by the Institut national d'excellence en santé et en services sociaux, they found that the publicly available information of PET-CTs was often out-of-date.(10; 11)

It is important to note that some of the jurisdictions included in the scan did not distinguish between PET and PET-CT units. Many of the PETs are integrated with a CT in order to improve accuracy of the scan.(12) We have made note of this where possible in Table 2.

Box 2: Identification, selection and synthesis of research evidence

We undertook a scan of 18 comparator jurisdictions that were pre-determined by the requestor. These included each Canadian province, Australia, Belgium, France, Ireland, New Zealand, Spain, Switzerland, and the United Kingdom.

We used a four pronged-approach to conduct the jurisdictional scan. First, for provincial health systems in Canada, we used findings from the Canadian Agency for Drugs and Technologies in Health's Canadian Medical Imaging Inventory to gather data on PET-CTs, including the number machines, their locations and non-cancer indications used for imaging. Second, we purposefully sampled websites from each of the jurisdictions, which included reviewing the websites of the government agency responsible for health, key agencies or organizations involved in providing insurance for or delivering PET-CT imaging services, as well as key agencies or organizations responsible for health technology assessment and clinical-practice guidelines. Third, we identified reports and guidelines about the public provision of PET-CT imaging for non-cancer indications by searching (in January and February 2018) PubMed and Google using the following keywords: (PET-CT OR PET/CT) AND indication AND the name of each jurisdiction. Fourth, we consulted with experts in these jurisdictions with knowledge of the topic when information was not readily available.

Table 2: Jurisdictional scan of public provision and funding of PET-CT imaging for non-cancer indications

Jurisdiction	For what non-cancer indications?	How is it delivered?	How is it paid for?
Canada			
British Columbia	<ul style="list-style-type: none"> • PET-CT imaging is not provided for non-cancer indications 	<ul style="list-style-type: none"> • PET-CT imaging is not provided for non-cancer indications 	<ul style="list-style-type: none"> • PET-CT imaging is not provided for non-cancer indications
Alberta (2; 7; 13-15)	<ul style="list-style-type: none"> • Cardiology indications: <ul style="list-style-type: none"> ○ myocardial viability assessment ○ myocardial perfusion assessment ○ sarcoidosis • Inflammatory indication: <ul style="list-style-type: none"> ○ lymphadenopathy • Neurology indications: <ul style="list-style-type: none"> ○ refractory seizure ○ dementia 	<ul style="list-style-type: none"> • The PET-CT program is run by Alberta Health Services, and patients are referred to services through the provincial directory • Healthcare providers consult the Alberta Referral Directory for PET-CT referral information (e.g., referral wait times, referral forms and urgent referral processes) 	<ul style="list-style-type: none"> • PET-CT imaging for non-cancer indications are covered by the Alberta Health Care Insurance Plan
Saskatchewan (7; 16-19)	<ul style="list-style-type: none"> • Cardiology indications: <ul style="list-style-type: none"> ○ viability assessment ○ cardiac sarcoidosis • Neurology indications: <ul style="list-style-type: none"> ○ refractory seizure ○ dementia ○ other 	<ul style="list-style-type: none"> • Saskatchewan's single PET-CT unit is located in a hospital (Royal University Hospital in Saskatoon) • PET-CTs require advance booking from a physician 	<ul style="list-style-type: none"> • PET-CT imaging for the specified clinical indications are covered with a valid Saskatchewan Health Services card through the Saskatchewan Health Authority •
Manitoba (2; 7)	<ul style="list-style-type: none"> • Neurology indications: <ul style="list-style-type: none"> ○ refractory seizure ○ dementia 	<ul style="list-style-type: none"> • Manitoba's single PET-CT unit is located in a hospital (Health Sciences Centre in Winnipeg) 	<ul style="list-style-type: none"> • The province of Manitoba funds 2,000 scans per year for patients who meet the clinical indications, including oncology • Funding for PET-CTs comes from Cancer Care Manitoba's global budget as there is no fee schedule item to bill for the imaging <ul style="list-style-type: none"> ○ Unable to determine how PET-CTs are funded for non-cancer indications based on the available information
Ontario (2; 12; 20)	<ul style="list-style-type: none"> • Cardiology indication: <ul style="list-style-type: none"> ○ myocardial viability assessment • Neurology indication: <ul style="list-style-type: none"> ○ epilepsy 	<ul style="list-style-type: none"> • PET-CTs can be accessed through: <ul style="list-style-type: none"> ○ Ontario Health Insurance Plan, when there is evidence that the scan will benefit the patient; ○ the Ontario PET Registry, which makes scans available when there is some evidence for success but not enough to receive insurance; ○ provincial clinical trials, which have been approved by the PET Steering Committee and are being conducted by the Ontario Clinical Oncology Group; and ○ the Ontario PET Access Program, in 	<ul style="list-style-type: none"> • Three criteria must be met to receive coverage through the Ontario Health Insurance Plan: <ol style="list-style-type: none"> 1) sufficient evidence that the scan will benefit the patient; 2) advantages over other tests; and 3) approval by the Ministry of Health and Long-Term Care • The PET Scans Ontario Program is funded through the Ministry of Health and Long-Term Care (Uninsured Services) <ul style="list-style-type: none"> ○ Uninsured PET imaging services are paid for by PET Scans Ontario – however, patients must be covered under OHIP

Jurisdiction	For what non-cancer indications?	How is it delivered?	How is it paid for?
		which a panel of experts considers physician requests when patients do not meet eligibility criteria for the scan	<ul style="list-style-type: none"> The PET Steering Committee evaluates all other routes of PET-CT access (Ontario PET Registry, clinical trials, Ontario PET Access Program) <ul style="list-style-type: none"> The committee is made up of experts who review clinical situations where PET scans may be indicated, considering scientific evidence and prioritizing based on impact on patient care
Quebec (7; 10; 21; 22)	<ul style="list-style-type: none"> There are two categories of PET-CT use: <ul style="list-style-type: none"> recommended indicated in certain cases (e.g., use is limited to specific clinical indications) Recommended PET-CTs include the following cardiology indications: <ul style="list-style-type: none"> myocardial perfusion (when testing for myocardial viability or cardiac sarcoidosis) cardiac sarcoidosis cardiac tumours Indicated in certain cases includes: <ul style="list-style-type: none"> cardiology; <ul style="list-style-type: none"> myocardial perfusion (e.g., suspected/confirmed coronary artery disease or when previous stress imaging test was inconclusive) myocardial viability cardiac devices and prosthetic valve infections septic embolism vascular graft infection large vessel vasculitis inflammatory (and infectious); <ul style="list-style-type: none"> cardiac devices and prosthetic valve infections septic embolism vascular graft infection osteomyelitis of the axial skeleton osteomyelitis of the peripheral skeleton fever of unknown origin sarcoidosis indicated in certain cases large vessel vasculitis neurology; <ul style="list-style-type: none"> epilepsy neurocognitive disorders (when identifying the disease process could change treatment plan) Parkinson-like motor disorders (when diagnosis is uncertain) 	<ul style="list-style-type: none"> Tests must be requested by a healthcare professional 	<ul style="list-style-type: none"> Financing of PET-CTs is included in global budgets of hospitals and is not limited to any types of diagnostics or indications

Examining the Public Provision and Funding of PET-CT Imaging for Non-cancer Indications

Jurisdiction	For what non-cancer indications?	How is it delivered?	How is it paid for?
Nova Scotia (7; 13; 23)	<ul style="list-style-type: none"> • Inflammatory indication: <ul style="list-style-type: none"> ◦ lymphadenopathy • Neurology indication: <ul style="list-style-type: none"> ◦ refractory seizure • Other indications may be approved by Medical Services Insurance on an individual case basis 	<ul style="list-style-type: none"> • Nova Scotia's single PET-CT unit is located in a hospital (QE II Health Sciences Centre in Halifax) • Tests must be requested by a specialist 	<ul style="list-style-type: none"> • PET-CT imaging is funded through the Cancer Care Nova Scotia program • Unable to determine how PET-CTs are funded for non-cancer indications based on the available information
New Brunswick (24)	<ul style="list-style-type: none"> • PET-CT imaging is not provided for non-cancer indications 	<ul style="list-style-type: none"> • PET-CT imaging is not provided for non-cancer indications 	<ul style="list-style-type: none"> • PET-CT imaging is not provided for non-cancer indications
Prince Edward Island (4)	<ul style="list-style-type: none"> • The province does not have a PET-CT unit 	<ul style="list-style-type: none"> • PET-CT out-of-province imaging can be requested based on the clinical indication and is evaluated for approval by request from internist, respirologist or oncologist 	<ul style="list-style-type: none"> • While the province does not have a PET-CT unit, they do fund exams out-of-province
Newfoundland and Labrador (6; 25; 26)	<ul style="list-style-type: none"> • A PET-CT was recently added in the province, however specific indications were not identified through publicly available sources on websites reviewed 	<ul style="list-style-type: none"> • PET-CT imaging must be requested by a specialist 	<ul style="list-style-type: none"> • Unable to determine how PET-CTs are funded for non-cancer indications based on the available information
Australia (27-29)	<ul style="list-style-type: none"> • Cardiology indications: <ul style="list-style-type: none"> ◦ myocardial perfusion ◦ myocardial viability ◦ select cardiac studies • Neurology indications: <ul style="list-style-type: none"> ◦ refractory seizures (pre-surgical evaluation) ◦ diagnosis of dementia and Alzheimer's disease ◦ neurodegenerative disease clinical trials 	<ul style="list-style-type: none"> • There are 55 PET units in Australia (18 in New South Wales, 13 in Victoria, 13 in Queensland, six in Western Australia, two in South Australia, two in Tasmania, and one is located in the Australian Capital Territory) • Access to PET-CTs is either through hospitals, medical imaging clinics or regional cancer centres 	<ul style="list-style-type: none"> • Publicly funded PET-CTs are covered through Medicare <ul style="list-style-type: none"> ◦ Private clinics also offer PET-CT services through private insurance companies
Belgium (30; 31)	<ul style="list-style-type: none"> • Cardiology indication: <ul style="list-style-type: none"> ◦ myocardial viability assessment • Neurology indication: <ul style="list-style-type: none"> ◦ preoperative assessment of refractory epilepsy 	<ul style="list-style-type: none"> • In 2009, the maximum number of PET-CT units allowed was set at 13 by law • However, based on the number of PET-CT exams that have been charged, it can be assumed that several others are operational in private facilities • An analysis conducted in 2017, suggests that there are now 25 PET-CT units in Belgium(30) 	<ul style="list-style-type: none"> • As of 2009, the reimbursement of PET-CT imaging is limited to pre-determined indications (e.g., cardiology and neurology indications) • Reimbursement of officially non-reimbursed indications is possible via the "double tomography" nomenclature code • The Centre fédéral d'expertise des soins de santé recommended in 2009 that: 1) reimbursements must be linked to the prior registration of the clinical indication in a single, computerized and standardized register; 2) the list of reimbursed indications should be reviewed every three years; 3) compliance with the reimbursement criteria must be systematically monitored; and 4) that the "double tomography" code must be removed • The payment system for medical imaging in Belgium includes a mix of lump sums and fee-for-service: • A lump sum per admission to cover costs linked to the assessment of the clinical situation, and the choice of the most appropriate medical imaging test and the

Jurisdiction	For what non-cancer indications?	How is it delivered?	How is it paid for?
			<p>amount of the lump sum was determined at the national level</p> <ul style="list-style-type: none"> A second lump sum amount per admission determined by the hospital's case-mix (All Patient Refined Diagnostic Related Groups and severity level) and by the national average expenses for medical imaging per hospital stay A reduced fee-for-service theoretically equals 75% of the former value for the service (31)
France (32-40)	<ul style="list-style-type: none"> In 2005, the Haute Autorité de Santé published an evaluation and state of practices regarding PET-CT imaging, and the report primarily focused on cancer indications, but stated that an extension of the indications is to be expected (33) Cardiology indications: <ul style="list-style-type: none"> myocardial viability assessment cardiac sarcoidosis Inflammatory indications: <ul style="list-style-type: none"> evaluation of chronic osteomyelitis evaluation of fever of unknown origin Neurology indications: <ul style="list-style-type: none"> atypical dementia, or if there is suspicion of fronto-temporal degeneration or other focal atrophy 	<ul style="list-style-type: none"> In France, a ministerial order of 2004 fixed the number of medical imaging scanners (including PET-CT units) to one device per 800,000 inhabitants An analysis conducted in 2017 suggests that there are now 94 PET-CT units in France (11) Heavy imaging devices are regulated through two mechanisms: <ol style="list-style-type: none"> a facility planning mechanism through an accreditation process a pricing mechanism 	<ul style="list-style-type: none"> Publicly funded PET-CTs are covered through the public health insurance (the 'Sécurité sociale') for most cancer indications Unable to determine how PET-CTs are funded for non-cancer indications based on the available information
Ireland (41-46)	<ul style="list-style-type: none"> Cardiology indication: <ul style="list-style-type: none"> myocardial viability assessment Neurology indications: <ul style="list-style-type: none"> diagnosis of neurodegenerative dementia differentiation of Alzheimer's dementia from frontotemporal dementia differentiation of progressive supranuclear palsy, corticobasal degeneration or multisystem atrophy from Parkinson's disease refractory seizures Other <ul style="list-style-type: none"> pyrexia of unknown origin 	<ul style="list-style-type: none"> Ireland has eight PET-CT units (five are located in Dublin, one in Cork, one in Galway, and in Waterford) 	<ul style="list-style-type: none"> PET-CTs are not publicly funded in Ireland Some Irish citizens qualify for medical cards, based on a means test A medical card entitles the holder to free medical services and the cards are issued by the Health Service Executive, a publicly funded regulatory body Of the Irish hospitals providing PET-CT access, six are private hospitals In these settings, pre-approved indications are covered by the major private health insurance providers in Ireland The amount of coverage depends on the insurance plan
New Zealand (47)	<ul style="list-style-type: none"> Neurology indication: <ul style="list-style-type: none"> epilepsy 	<ul style="list-style-type: none"> There are six PET units in operation in New Zealand 	<ul style="list-style-type: none"> Insured services are funded by Medicare for public access, and private insurance companies when services are accessed in private clinics
Spain (48)	<ul style="list-style-type: none"> Details not identified from publicly available sources on websites reviewed 	<ul style="list-style-type: none"> Spain has a total of 65 publicly funded PET units, however it is unclear if there are any publicly funded PET-CTs for non-cancer indications 	<ul style="list-style-type: none"> Details not identified from publicly available sources on websites reviewed

Jurisdiction	For what non-cancer indications?	How is it delivered?	How is it paid for?
Switzerland (11; 49-54)	<ul style="list-style-type: none"> • In 2016, about 8% of all clinical PET-CT scans were performed for non-cancer indications • Of those, about one-third was for cardiology, inflammatory/infection and neurology indications • Cardiology indications: <ul style="list-style-type: none"> ○ preoperative measure before a heart transplant ○ viability of the myocardium - exclusively distinction between scar and myocardium viable on chronic ischemia (hibernating myocardium) • Inflammatory indications: <ul style="list-style-type: none"> ○ vascular prosthesis infection - exclusion of prosthesis infection ○ abdominal sepsis ○ fever of undetermined origin - investigation of infectious focus ○ investigation of infectious focus/ inflammatory disease • Neurology indications: <ul style="list-style-type: none"> ○ preoperative measure for focal epilepsy resistant to therapy ○ epileptogenic focus in temporal and extra-temporal epilepsy ○ diagnosis of dementia: as a supplementary examination in unclear cases, after prior examination by specialists in geriatrics, psychiatry or neurology; up to the age of 80, with a Folstein test (Mini-Mental-Status-Test) of at least 10 points and dementia lasting for a maximum of five years; no PET or TEMP screening ○ diagnosis of early multi-system degeneration • Other <ul style="list-style-type: none"> ○ mass effect - differentiation between toxoplasmosis and lymphoma ○ chronic pancreatitis - distinction of a possible pancreatic neoplasia ○ pulmonary nodules of undetermined origin - distinction of a possible neoplasia ○ single lung nodule - distinction of a possible neoplasia ○ suspicious mediastinal pathology - in case of ambiguous diagnosis, cellar, tuberculosis, sarcoidosis 	<ul style="list-style-type: none"> • In Switzerland every university hospital and most of the large clinics have a PET-CT unit • An analysis conducted in 2017 suggests that there are now 28 PET-CT units in Switzerland,(11) however other sources indicate there are between 30-35 units (53) 	<ul style="list-style-type: none"> • There is a negative and conditional list for medical services and procedures in place in Switzerland • All medical services or procedures, which are efficient, appropriate and cost-effective, are covered by the social health insurance unless challenged by a health insurer • The PET Working Group, the Société Suisse de Médecine Nucléaire, may submit requests for the management of new indications, the effectiveness, adequacy and cost-effectiveness of which has been demonstrated in studies published according to the STARD reporting guideline for diagnostic accuracy studies)(54)

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Jurisdiction	For what non-cancer indications?	How is it delivered?	How is it paid for?
United Kingdom			
England (55; 56)	<ul style="list-style-type: none"> Current NHS policy allows for non-cancer related PET-CT imaging to amount to up to 10% of total oncological activity Cardiology indications: <ul style="list-style-type: none"> myocardial viability assessment vasculitis (selected cases where conventional investigations unhelpful) sarcoidosis (assessment of disease) infection imaging (e.g. detection of infection site, evaluation of vascular graft or device-related infection) Inflammatory indication: <ul style="list-style-type: none"> pyrexia of unknown origin (identify cause) Neurology indications: <ul style="list-style-type: none"> pre-surgical assessment evaluation of dementia 	<ul style="list-style-type: none"> PET-CT services are directly commissioned within NHS England Service delivery occurs through a number of providers including NHS trusts, research institutes, the independent sector, and charitable organizations Non-cancer PET-CT services are at discretion of the Administration of Radioactive Substances Advisory Committee certificate holders 	<ul style="list-style-type: none"> Services are commissioned by NHS England
Wales (57)	<ul style="list-style-type: none"> Cardiology indication: <ul style="list-style-type: none"> myocardial viability assessment (on a case-by-case basis) 	<ul style="list-style-type: none"> Based on geographic location, clinicians must refer to a specific location: <ul style="list-style-type: none"> South East and West Wales: University Hospital of Wales, Cardiff North Wales and parts of Mid Wales: Wrexham Maelor Hospital, Wrexham Mid Wales (close to Manchester): The Christie, Manchester 	<ul style="list-style-type: none"> Patients meeting the criteria for treatment are covered by the NHS If the patient does not meet the criteria for treatment, but the physician believes there are exceptional circumstances, an Individual Patient Funding Request can be made to Welsh Health Specialised Services Committee
Scotland (58)	<ul style="list-style-type: none"> Recommendations provided by the National Services Division and some are advised to be 'not routinely commissioned', which are considered to be exceptional cases (e.g., considered on a case-by-case basis) Cardiology indications: <ul style="list-style-type: none"> vasculitis sarcoidosis (not routinely commissioned) Inflammatory indications: <ul style="list-style-type: none"> infection imaging (not routinely commissioned) pyrexia of unknown origin (not routinely commissioned) Other <ul style="list-style-type: none"> radiotherapy planning 	<ul style="list-style-type: none"> PET-CT imaging is provided in four sites in Scotland (Aberdeen, Dundee, Edinburgh and Glasgow) 	<ul style="list-style-type: none"> Funding is provided by the Scottish Government Health and Social Care Directorates across four provider boards (Aberdeen, Dundee, Edinburgh and Glasgow – based on the number of scans provided by each board)

For what non-cancer indications is there public provision and funding of PET-CT imaging?

Canada

There is great variability across Canadian provinces in terms of access to and criteria for PET-CT imaging for non-cancer indications. The most recent data from the Canadian Medical Imaging Inventory II highlights the variability in publicly funded PET-CTs for non-cancer indications. While only 11 of the 51 PET-CTs captured in the report provided data on clinical indications, the results help to give a sense for how PET-CTs are being used in Canada. Table 3 provides the broad categories of clinical indications by PET-CT site. Information was not available on location of the individual PET-CTs. The percentage totals for clinical indications for the Canadian Medical Imaging Inventory II are as follows:

- oncology 77%;
- cardiology 13%;
- neurology 8%;
- inflammatory 1%; and
- other 1%.(8)

Table 3: Clinical indications for publicly funded PET-CTs in Canada

	Clinical indication				
	Cardiology	Inflammatory	Neurology	Oncology	Other
PET-CT site 1	0	2	3	94	1
PET-CT site 2	0	0	1	99	0
PET-CT site 3	0	0	1	99	0
PET-CT site 4	0	0	50	50	0
PET-CT site 5	95	5	0	0	0
PET-CT site 6	0	0	0	100	0
PET-CT site 7	0	0	0	100	0
PET-CT site 8	0	5	15	70	10
PET-CT site 9	0	3	6	90	1
PET-CT site 10	0	1	0	98	1
PET-CT site 11	43	0	7	50	0
Total	138	16	83	850	13

Source: (8)

Three provinces do not provide PET-CTs for non-cancer indications (British Columbia, New Brunswick and Newfoundland and Labrador), and Prince Edward Island does not have a PET-CT unit. Of the provinces that provide PET-CT imaging for non-cancer indications, the most common are cardiology-related (e.g., myocardial viability assessment) and neurology-related (e.g., epilepsy/refractory seizure or dementia).

Access to PET-CT services in Quebec are among the best in Canada.(7; 10; 21; 22) There are 16 publicly funded PET-CT scanners in the province. The list of non-cancer indications is the most extensive of all the jurisdictions scanned and broken down into two categories: 1) recommended; and 2) indicated in certain cases (e.g., use is limited to specific clinical indications).(7; 10; 21; 22)

Select comparator countries

With the exception of Spain, all of the select comparator jurisdictions provide publicly funded PET-CTs for non-cancer indications to varying degrees.(59) The European Association of Nuclear Medicine, the umbrella organization for nuclear imaging in Europe, has published two reports on the application of PET-CTs beyond cancer, with a focus on application in the fields of cardiology, infection and inflammation, and neurology.(60; 61)

In Belgium, a review conducted in 2009 by the Centre fédéral d'expertise des soins de santé highlighted the need to regularly update the evidence on PET-CT to reflect the growing body of research evidence on clinical indications.(30) The review listed potential indications for PET-CTs, but concluded that the evidence was inconclusive for some indications (e.g., evaluation of chronic osteomyelitis, prosthetic joint infections, and fever of unknown origin).(30) The Belgium Ministry of Health has a platform featuring recommendations for the correct use of medical imaging.(62)

In France, the French Society of Radiology and the French Society of Nuclear Medicine under the Haute Autorité de Santé and the Nuclear Safety Authority published the Guide to the Proper Use of Medical Imaging Exams.(32) In 2005, the Haute Autorité de Santé published an evaluation and state of practices regarding PET-CT imaging. While the report primarily focused on cancer indications, it stated that an extension of the indications is anticipated.(33) The guide is an online database and resource for physicians providing guidance on requesting medical imaging.(32)

In Switzerland, every university hospital and most of the large clinics have PET-CT units. There are conflicting reports on the total number of PET-CT units in Switzerland. One recent analysis published in 2017 states that there are 28 PET-CT units,(11) however, other sources indicate there are between 30-35 units.(53)

How is publicly funded PET-CT imaging for non-cancer indications delivered?

Across all jurisdictions, the primary location of PET-CT units is in hospitals. In addition, referral to PET-CT imaging is through a healthcare professional, most often a specialist.

How is publicly funded PET-CT imaging for non-cancer indications paid for?

As outlined previously, information regarding how PET-CTs for non-cancer indications are funded was difficult to access, and many times the data was not publicly available. In Canada, with the exception of Quebec and Ontario, we were unable to determine how PET-CTs are funded for non-cancer indications based on the available information. In Quebec, PET-CT funding is included in global budgets of hospitals and is not limited to any types of diagnostics or indications. In Ontario, in order to receive coverage through the Ontario Health Insurance Plan there must be: 1) sufficient evidence that the scan will benefit the patient; 2) advantages over other tests; and 3) approval by the Ministry of Health and Long-Term Care.(20)

Within the select comparator countries, PET-CTs for the listed non-cancer indications are paid for through public insurance plans. In Belgium, we were able to find further details, and funding for PET-CTs includes a mix of lump sums and fee-for-service:

- a lump sum per admission to cover costs linked to the assessment of the clinical situation, and the choice of the most appropriate medical imaging test and the amount of the lump sum was determined at the national level;
- a second lump sum amount per admission determined by the hospital's case-mix (all patient refined diagnostic related groups and severity level) and by the national average expenses for medical imaging per hospital stay; and
- a reduced fee-for-service theoretically equals 75% of the former value for the service.(31)

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