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Positron Emission Tomography–Computed Tomography for Patients with Suspected or Confirmed Coronary Artery Disease: Clinical Utility, Cost-Effectiveness, and Diagnostic Accuracy

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

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Research Questions

1. What is the clinical utility of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve?
2. What is the cost-effectiveness of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve?
3. What is the clinical evidence regarding the safety of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve?
4. What is the diagnostic accuracy of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve?

Key Findings

One randomized controlled trial and one non-randomized study were identified regarding the clinical utility of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve. In addition, three systematic reviews (two with meta-analyses) and 14 non-randomized studies were identified regarding the diagnostic accuracy of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve. One of the non-randomized studies also addressed the safety of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve. No relevant literature was identified regarding the cost-effectiveness of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve.

Methods

Literature Search Methods

A limited literature search was conducted by an information specialist on key resources including Medline and EMBASE via OVID, the Cochrane Library, the University of York Centre for Reviews and Dissemination (CRD) databases, the websites of Canadian and major international health technology agencies, as well as a focused internet search. The search strategy was comprised of both controlled vocabulary, such as the National Library of Medicine's MeSH (Medical Subject Headings), and keywords. The main search concepts were position emission tomography computed tomography (PET/CT), and coronary artery disease. No filters were applied to limit the retrieval by study type. The search was also limited to English language documents published between January 1, 2010 and September 24, 2020. Internet links are provided where available.

Selection Criteria

One reviewer screened literature search results (titles and abstracts) and selected publications according to the inclusion criteria presented in Table 1. Full texts of study publications were not reviewed.

Table 1: Selection Criteria

Population	Patients with suspected or confirmed coronary artery disease or acute coronary syndrome (unstable angina) with cardiac perfusion abnormalities or myocardial ischemia
Intervention	PET–CT or PET for the detection of cardiac perfusion and coronary flow reserve (Q4: Reference test: FFR or measurement of coronary flow reserve during invasive angiography)
Comparator	Q1-2: SPECT; Invasive angiography Q3-4: SPECT; No comparator (Q4: FFR or measurement of coronary flow reserve during invasive angiography)
Outcomes	Q1: Clinical utility: detecting cardiac perfusion (based on coronary flow reserve) to determine clinical decisions such as pharmaceutical treatment, coronary artery bypass surgery, coronary artery stents/ revascularization; hospitalization; mortality Q2: Cost-effectiveness Q3: Safety (e.g., radiation dose/exposure) Q4: Diagnostic accuracy: sensitivity, specificity, accuracy, positive predictive value, negative predictive value, cardiac perfusion detection rate
Study Designs	Health technology assessment, systematic reviews, randomized controlled trials, non-randomized studies, economic evaluations

FFR = fractional flow reserve; PET = positron emission tomography; PET-CT = positron emission tomography – computed tomography; SPECT = single-photon emission computed tomography

Results

One randomized controlled trial[4] and one non-randomized study[5] were identified regarding the clinical utility of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve. In addition, three systematic reviews[1-3] (two with meta-analyses[1,2]) and 14 non-randomized studies[6-19] were identified regarding the diagnostic accuracy of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve. One of the non-randomized studies[6] also addressed the safety of positron emission tomography–computed tomography in patients to detect coronary artery disease and to measure coronary flow reserve. No health technology assessments or economic evaluations were identified.

Additional references of potential interest that did not meet the inclusion criteria are provided in the appendix.

Health Technology Assessments

No literature identified.

Systematic Reviews and Meta-Analyses

Diagnostic Accuracy

1. Jaarsma C, Leiner T, Bekkers SC, et al. Diagnostic performance of noninvasive myocardial perfusion imaging using single-photon emission computed tomography, cardiac magnetic resonance, and positron emission tomography imaging for the detection of obstructive coronary artery disease: a meta-analysis. *J Am Coll Cardiol*. 2012 May 8;59(19):1719-1728.
PubMed: PM22554604

2. Parker MW, Iskandar A, Limone B, et al. Diagnostic accuracy of cardiac positron emission tomography versus single photon emission computed tomography for coronary artery disease: a bivariate meta-analysis. *Circ Cardiovasc Imaging*. 2012 Nov;5(6):700-707.
PubMed: PM23051888

3. Al Moudi M, Sun Z, Lenzo N. Diagnostic value of SPECT, PET and PET/CT in the diagnosis of coronary artery disease: a systematic review. *Biomed Imaging Interv J*. 2011 Apr;7(2):e9.
PubMed: PM22287989

Randomized Controlled Trials

Clinical Utility

4. Patel KK, Al Badarin F, Chan PS, et al. Randomized comparison of clinical effectiveness of pharmacologic SPECT and PET MPI in symptomatic CAD patients. *JACC Cardiovasc Imaging*. 2019 Sep;12(9):1821-1831.
PubMed: PM31326480

Non-Randomized Studies

Clinical Utility

5. Knight S, Min DB, Le VT, et al. Implementation of a cardiac PET stress program: Comparison of outcomes to the preceding SPECT era. *JCI Insight*. 2018 May;3(9):e120949.
PubMed: PM29720565

Diagnostic Accuracy and Safety

6. Maddahi J, Lazewatsky J, Udelson JE, et al. Phase-III clinical trial of fluorine-18 flurpiridaz positron emission tomography for evaluation of coronary artery disease. *J Am Coll Cardiol*. 2020 28 July;76(4):391-401.
PubMed: PM32703509

Diagnostic Accuracy

7. Acampa W, Zampella E, Assante R, et al. Quantification of myocardial perfusion reserve by CZT-SPECT: a head to head comparison with 82 Rubidium PET imaging. *J Nucl Cardiol*. 2020 May 7.
PubMed: PM32383083

8. Bendix K, Thomassen A, Junker A, Veien KT, Jensen LO. 15 O-water positron emission tomography of myocardial ischemia in patients referred for percutaneous coronary intervention. *Cardiovasc Revasc Med*. 2020 Mar 7;S1553-8389(20)30142-1.
PubMed: PM32247563

9. Hyafil F, Chequer R, Sorbets E, et al. Head-to-head comparison of the diagnostic performances of Rubidium-PET and SPECT with CZT camera for the detection of myocardial ischemia in a population of women and overweight individuals. *J Nucl Cardiol*. 2020 01 Jun;27(3):755-768.
PubMed: PM30574676

10. Fathala A, Aboulkheir M, Shoukri MM, Alsergani H. Diagnostic accuracy of (13)N-ammonia myocardial perfusion imaging with PET-CT in the detection of coronary artery disease. *Cardiovasc Diagn Ther*. 2019 Feb;9(1):35-42.
PubMed: PM30881875

11. Brophey MD, Farukhi IM, Castanon R, DeLaPena R, Bradshaw L, Banerjee S. Accuracy of (82)Rb PET/CT myocardial perfusion imaging with regadenoson stress, including 3-year clinical outcomes. *J Nucl Med Technol*. 2017 Jun;45(2):75-81.
PubMed: PM28408703

12. Danad I, Raijmakers PG, Driessen RS, et al. Comparison of coronary CT angiography, SPECT, PET, and hybrid imaging for diagnosis of ischemic heart disease determined by fractional flow reserve. *JAMA Cardiol*. 2017 Oct;2(10):1100-1107.
PubMed: PM28813561

13. Dou KF, Gao XJ, Xie BQ, Li Y, He ZX, Yang MF. Dual-time-point myocardial (18)F-FDG imaging in the detection of coronary artery disease. *BMC Cardiovasc Disord*. 2017 May 10;17(1):120.
PubMed: PM28490354

14. Dou KF, Xie BQ, Gao XJ, et al. Use of resting myocardial 18F-FDG imaging in the detection of unstable angina. *Nucl Med Commun*. 2015 Oct;36(10):999-1006.
PubMed: PM26225939

15. Al Moudi M, Sun ZH. Diagnostic value of (18)F-FDG PET in the assessment of myocardial viability in coronary artery disease: a comparative study with (99m)Tc SPECT and echocardiography. *J Geriatr Cardiol*. 2014 Sep;11(3):229-236.
PubMed: PM25278972

16. Berman DS, Maddahi J, Tamarappoo BK, et al. Phase II safety and clinical comparison with single-photon emission computed tomography myocardial perfusion imaging for detection of coronary artery disease: flurpiridaz F 18 positron emission tomography. *J Am Coll Cardiol*. 2013 Jan 29;61(4):469-477.
PubMed: PM23265345

17. Hsiao E, Ali B, Blankstein R, et al. Detection of obstructive coronary artery disease using regadenoson stress and 82Rb PET/CT myocardial perfusion imaging. *J Nucl Med*. 2013 Oct;54(10):1748-1754.
PubMed: PM23940305

18. Nakazato R, Berman DS, Dey D, et al. Automated quantitative Rb-82 3D PET/CT myocardial perfusion imaging: normal limits and correlation with invasive coronary angiography. *J Nucl Cardiol*. 2012 Apr;19(2):265-276.
PubMed: PM22203445

19. Kajander S, Joutsiniemi E, Saraste M, et al. Cardiac positron emission tomography/computed tomography imaging accurately detects anatomically and functionally significant coronary artery disease. *Circulation*. 2010 Aug 10;122(6):603-613.
PubMed: PM20660808

Economic Evaluations

No literature identified.

Appendix — Further Information

Previous CADTH Reports

20. Smith A, Loshak H. PET-CT for cardiology: a rapid qualitative evidence synthesis of patients' and caregivers' perspectives and experiences [*CADTH rapid response report: summary with critical appraisal*]. Ottawa (ON): CADTH; 2019 Mar; https://cadth.ca/sites/default/files/pdf/htis/2019/RC1081%20PET-CT%20for%20Cardiology%20Final.pdf Accessed 2020 Oct 08.

21. Pejic W, Ford C, Argáez C. Positron emission tomography–computed tomography for cardiovascular indications: diagnostic accuracy, clinical utility, cost-effectiveness, and guidelines [*CADTH rapid response report: summary of abstracts*]. Ottawa (ON): CADTH; 2018 Aug; https://www.cadth.ca/sites/default/files/pdf/htis/2018/RB1244%20PET-CT%20for%20Cardiovascular%20Indications%20Final.pdf Accessed 2020 Oct 08

22. Mujoomdar M, Clark M, Nkansah E. Positron emission tomography for cardiovascular disease: a review of the clinical effectiveness [*CADTH rapid response report: peer reviewed summary with critical appraisal*]. Ottawa (ON): CADTH; 2010 Aug; https://cadth.ca/sites/default/files/pdf/M0015_PET_for_Cardiology_e.pdf Accessed 2020 Oct 08.

Non-Randomized Studies

Clinical Utility – Mixed Comparator

23. Ma Q, Sridhar G, Power T, Agiro A. Assessing the downstream value of first-line cardiac positron emission tomography (PET) imaging using real world Medicare fee-for-service claims data. *J Nucl Cardiol*. 2019 Dec 9. PubMed: PM31820411

Diagnostic Accuracy – Alternative Comparator

24. Thomassen A, Braad PE, Pedersen KT, et al. 15-O-water myocardial flow reserve PET and CT angiography by full hybrid PET/CT as a potential alternative to invasive angiography. *Int J Cardiovasc Imaging*. 2018 Dec;34(12):2011-2022. PubMed: PM30066164

25. Thomassen A, Petersen H, Diederichsen AC, et al. Hybrid CT angiography and quantitative 15O-water PET for assessment of coronary artery disease: comparison with quantitative coronary angiography. *Eur J Nucl Med Mol Imaging*. 2013 Dec;40(12):1894-1904. PubMed: PM23982453

Diagnostic Accuracy – Unclear Outcomes

26. Plass A, Emmert MY, Gaemperli O, et al. The potential value of hybrid positron emission tomography/dual-source computed tomography imaging in coronary bypass surgery. *Heart Surg Forum*. 2011 Oct;14(5):E283-290. PubMed: PM21997649

Unclear Abstract

27. Srivatsava MK, Indirani M, Sathyamurthy I, Sengottuvelu G, Jain AS, Shelley S. Role of PET-CT in the assessment of myocardial viability in patients with left ventricular dysfunction. *Indian Heart J*. 2016 Sep-Oct;68(5):693-699. PubMed: PM27773409

28. Raja S, Singh B, Rohit MK, et al. Comparison of nitrate augmented Tc-99m tetrofosmin gated SPECT imaging with FDG PET imaging for the assessment of myocardial viability in patients with severe left ventricular dysfunction. *J Nucl Cardiol*. 2012 Dec;19(6):1176-1181. PubMed: PM22872319

Review Articles

29. Santos BS, Ferreira MJ. Positron emission tomography in ischemic heart disease. *Rev Port Cardiol*. 2019 Aug;38(8):599-608. PubMed: PM31694787

30. Kazakauskaitė E, Žaliaduonytė-Pekšienė D, Rumbinaitė E, Keršulis J, Kulakienė I, Jurkevičius R. Positron emission tomography in the diagnosis and management of coronary artery disease. *Medicina (Kaunas)*. 2018 Jul 11;54(3). PubMed: PM30344278

Additional Reference

31. Mattison C, Gauvin FP, Wilson MG. Examining the public provision and funding of PET-CT imaging for non-cancer indications: rapid synthesis. Hamilton (ON): McMaster Health Forum, McMaster University; 2018 Feb: https://www.mcmasterforum.org/docs/default-source/product-documents/rapid-responses/examining-the-public-provision-and-funding-of-pet-ct-imaging-for-non-cancer-indications.pdf Accessed 2020 Oct 08.