

Registry of nuclear medicine procedures in cardiology in Poland in 2019–2021

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Abstract

Background: The purpose of the study was to present the cardiological procedures performed and scintigraphic devices used in Poland in 2019–2021 — based on the results of a nationwide survey.

Material and methods: Forty-three (100%) institutions performing scintigraphic cardiology tests responded to the survey: 29 classic nuclear medicine centers (NM), 4 PET centers, and 10 institutions performing NM and PET examinations.

Results: In 2021, 51 SPECT devices (including 5 dedicated cardiocentric semiconductor cameras, 12 SPECT gamma cameras, and 39 hybrid SPECT/CT devices) and 15 PET devices (14 PET/CT and 1 PET/MR) were used for cardiological examinations. The total number of cardiological SPECT and PET examinations has reached 33,107; PET shares 0.8%. The most frequently performed NM cardiological examination in 2019–2021 was myocardial perfusion scintigraphy (98–99% of all tests). NM cardiac amyloidosis studies accounted for less than 1% of all studies, and diagnostics of inflammation in the chest using labeled leukocytes — for less than 0.5%. The most frequently performed cardiological heart examination using the PET technique was the diagnostics of inflammation in the chest (166 of 269 examinations, i.e. 61.7%, in 2021), followed by the assessment of cardiac viability (46 examinations, i.e. 17.1%).

Conclusions: In Poland, in 2021, cardiac scintigraphy was performed in 39 classic nuclear medicine centers and 14 PET centers, using modern equipment, in approximately 1/1000 inhabitants per year. Polish nuclear cardiology is based on classical nuclear medicine. Almost 99% of the tests are stress and rest myocardial perfusion studies. PET has limited practical use (< 1% of cardiac studies).

KEYwords: nuclear cardiology; myocardial perfusion scintigraphy; infection/inflammation scintigraphy; cardiac amyloidosis scintigraphy; SPECT; SPECT/CT; PET

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Introduction

The guidelines of the European Society of Cardiology ESC (and the Polish Society of Cardiology PTK) cover 11 clinical situations taking into account radioisotope diagnostics. Nine of them contain indications for myocardial perfusion scintigraphy (MPS) using the SPECT or PET technique, six of which have class I indications [1–6]. In infective endocarditis (IE), performing a PET scan using [¹⁸F]FDG is a class I indication, and the classic nuclear medicine (NM)

studies using labeled leukocytes — class IIa [7]. In suspected transthyretin cardiac amyloidosis (ATTR), NM scintigraphy using bone markers is a class I indication [8]. The aim of the study is to present the number and types of cardiac procedures performed and scintigraphic devices used in Poland in 2019–2021.

Material and methods

The data included in the report are based on the responses contained in a survey sent in 2022 to the heads of all nuclear medicine departments performing (among others) nuclear cardiology. The list of the departments was provided by provincial consultants in the field of nuclear medicine. The survey contained questions concerning equipment and number and type of nuclear cardiology studies regarding 2019–2021 activity. 100% of departments responded to the survey.

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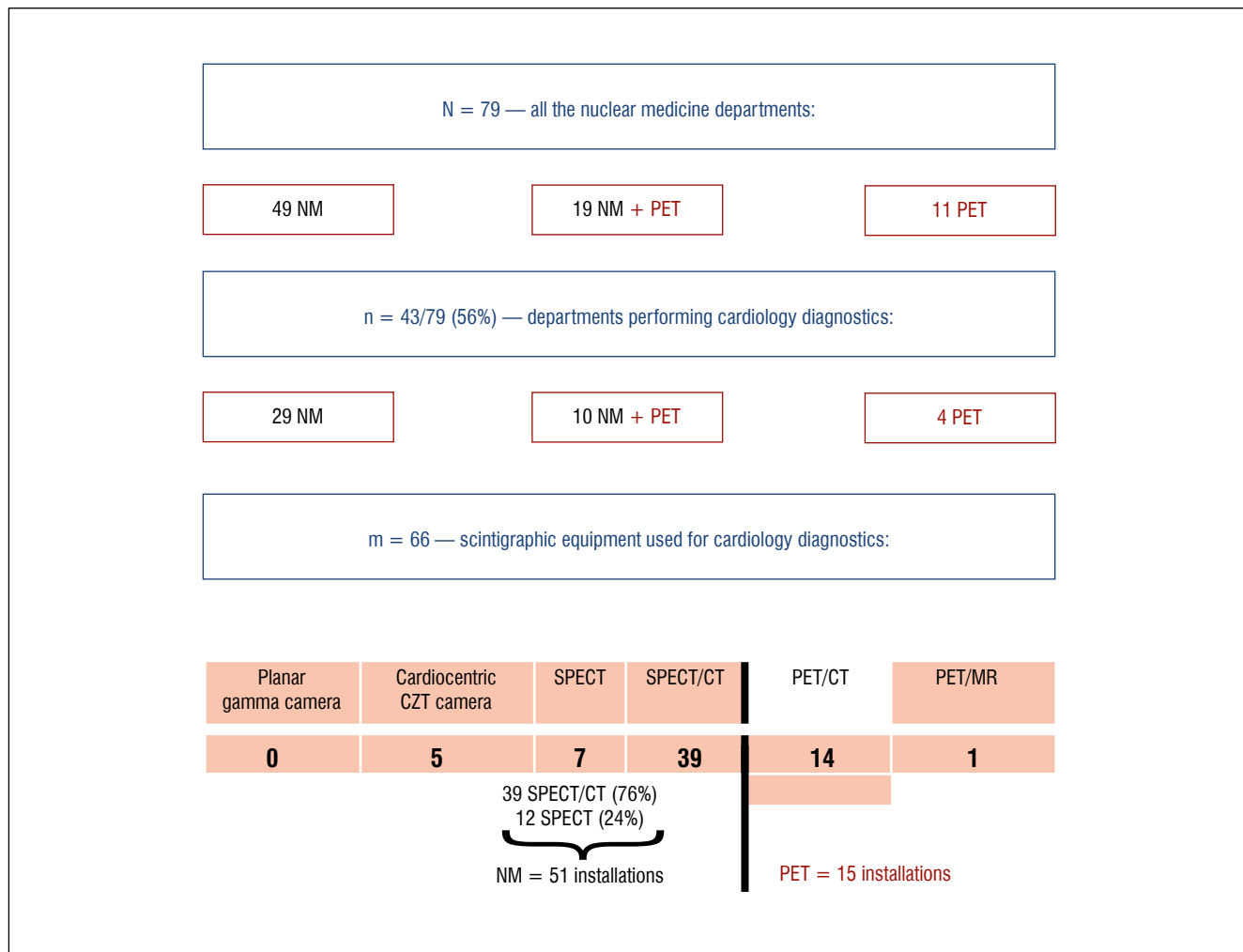


Figure 1. Number of nuclear medicine departments and equipment in Poland in 2021. CT — computed tomography; CZT — cadmium-zinc-telluride; MR — magnetic resonance; NM — classic nuclear medicine; PET — positron emission tomography

Results

Organizational workforce

In 2021, there were 79 departments of nuclear medicine in Poland — 49 performing conventional nuclear medicine imaging (NM), 11 performing PET, and 19 performing NM as well as PET imaging (Fig. 1).

Forty-three (56%) of the departments were performing nuclear cardiology — 29 NM centers, 4 PET centers, and 10 NM-and-PET centers. In those departments, 66 diagnostic devices were used for cardiac diagnostic purposes: 51 NM devices and 15 PET devices (14 PET/CT and one PET/MR). NM installations included 39 SPECT/CT, 7 SPECT, and 5 cardiocentric CZT (cadmium-zinc-telluride) cameras (Fig. 1).

NM cardiology studies

In 2021, the total number of cardiological SPECT and PET examinations reached 33,107, which was a result very similar to

the result from 2019 (32,697) (Fig. 2). PET share was only 0.8% (269 examinations).

The total number of NM cardiology studies in 2021 was 32,838. The most frequently performed cardiological examination in 2019–2021 was myocardial perfusion scintigraphy. Stress and rest perfusion studies during those years accounted for 32,295, 26,257, and 32,368 procedures (97.6%, 98.9%, and 98.6%, respectively) (Fig. 3).

Cardiac stress tests accompanying myocardial perfusion scintigraphy in 2021 were:

- exercise on a treadmill or ergometer (10,912 tests, 66%),
- pharmacological load [5,694 tests, including vasodilators dipyridamole 5,385 (32%) or regadenoson 246 (1.5%), and dobutamine 63 (0.4%)].

The highest proportion of exercise is in accordance with the guidelines that recommend dynamic exercise as the first test of choice in patients with suspected or known coronary artery disease, who constitute the largest group of patients examined

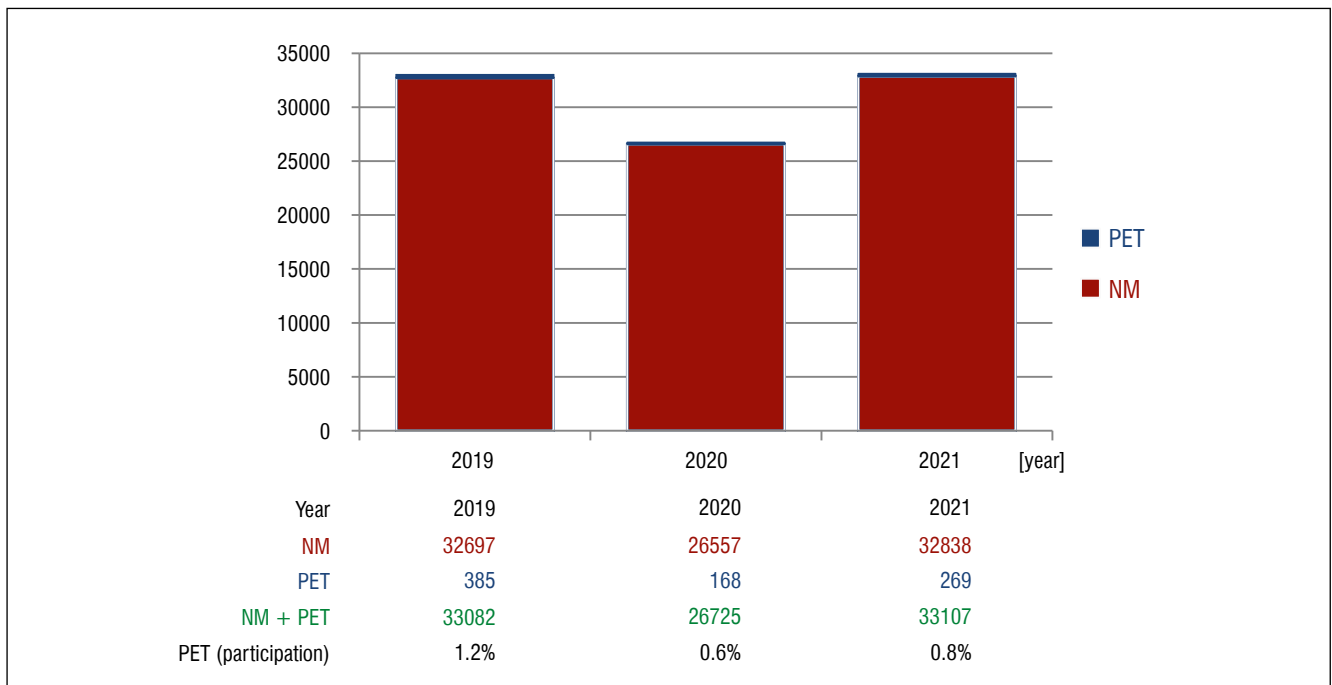


Figure 2. Number and type of nuclear medicine cardiology studies in 2019–2021. NM — classic nuclear medicine; PET — positron emission tomography

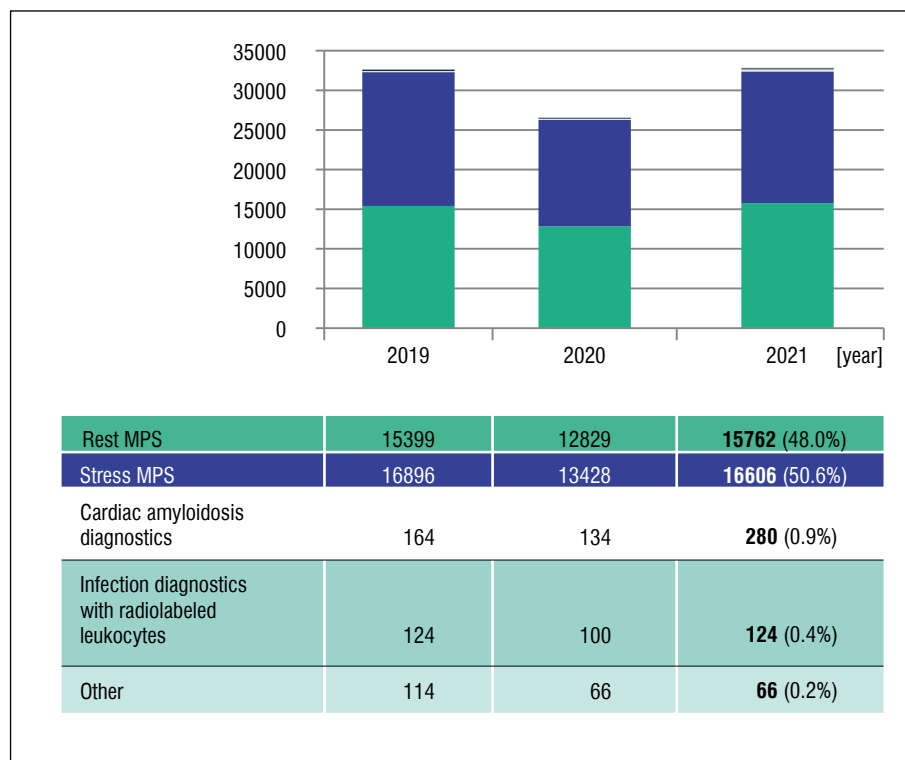


Figure 3. Number and type of classic nuclear medicine cardiology studies in 2019–2021. Numbers in brackets indicate the percentage of tests in relation to the total number of NM tests in 2021. MPS — myocardial perfusion scintigraphy; NM — classic nuclear medicine

using MPS [9]. Dipyridamole was the most commonly used pharmacological drug due to its mild side effects and low price.

The radiopharmaceutical used in 100% of the MPS studies was methoxy-isobutyl-isonitrile (MIBI) labeled with technetium ^{99m}Tc, i.e. [^{99m}Tc]Tc-MIBI (Fig. 4).

A non-invasive diagnostic imaging algorithm using ^{99m}Tc-labeled bone-seeking agents, such as [^{99m}Tc]Tc-DPD (2,3-dicarboxypropane-1,1-diphosphonate), [^{99m}Tc]Tc-HDMP (hydroxymethylene diphosphonate), or [^{99m}Tc]Tc-PYP (pyrophosphate) has been accepted for the diagnosis of transthyretin cardiac amyloidosis (ATTR-CA) [10–12].

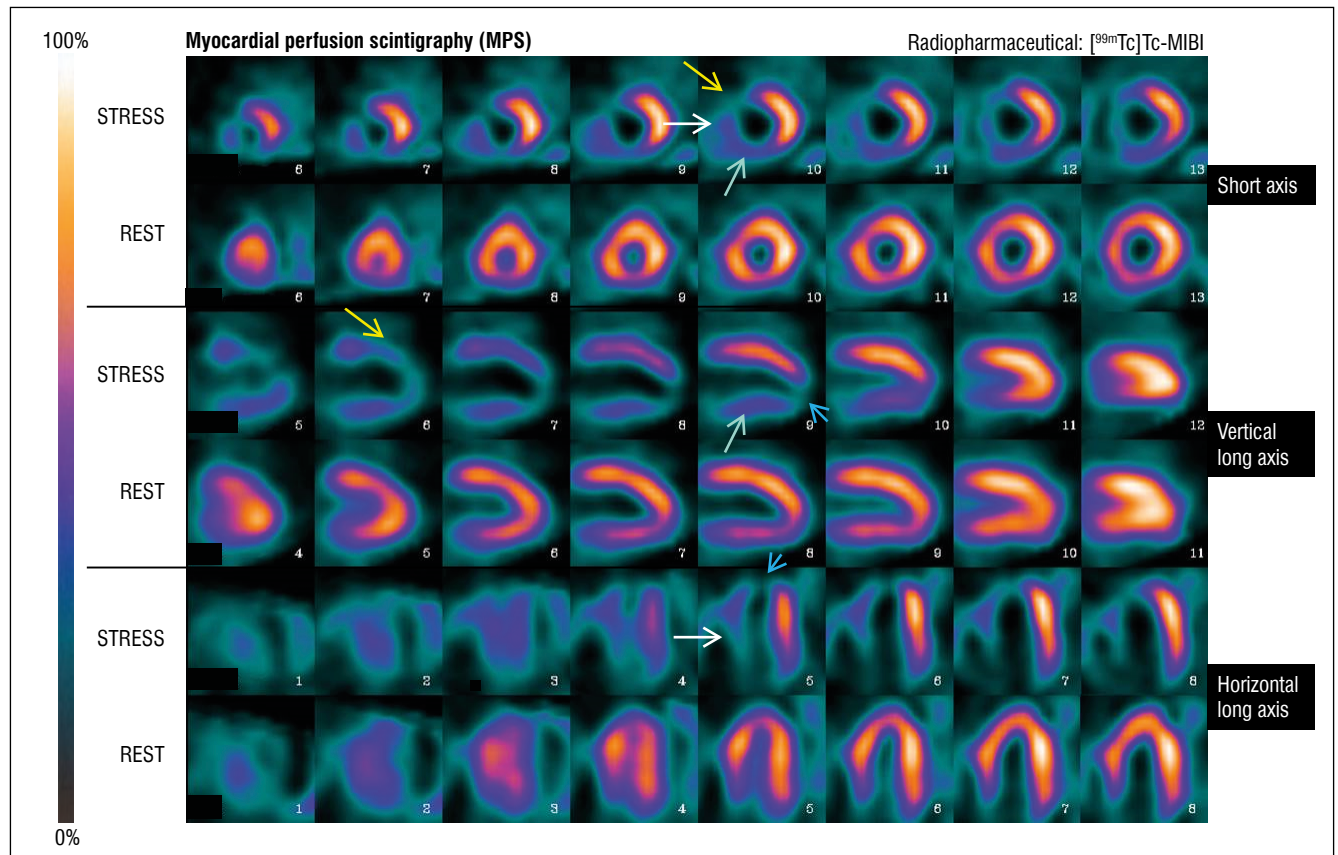


Figure 4. Example of the results of $[^{99m}\text{Tc}]\text{Tc-MIBI}$ myocardial perfusion SPECT study. Stress-induced myocardial ischemia is diagnosed on the basis of severe stress, reversing in rest, perfusion defects in the anteroseptal wall (yellow arrows), septum (white arrows), inferior wall (turquoise arrows), and apex (short blue arrows). MIBI — methoxy-isobutyl-isonitrile; SPECT — single photon emission computed tomography

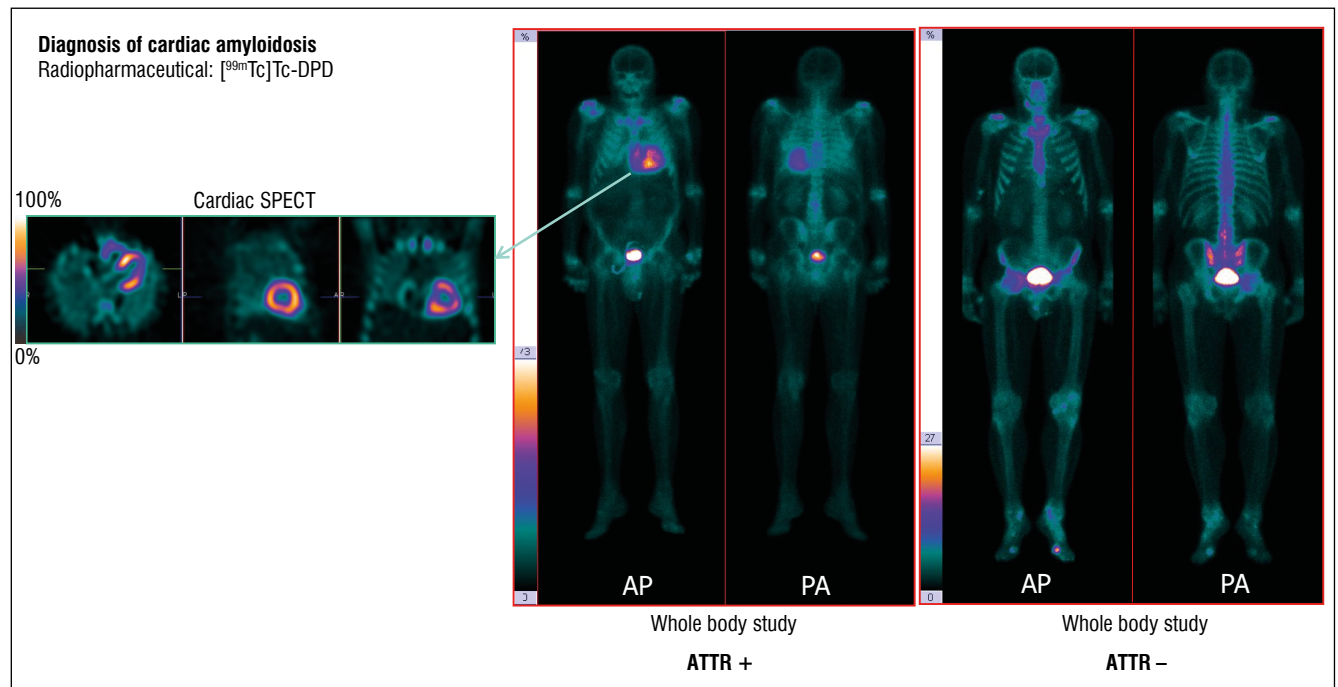


Figure 5. Example of the results of $[^{99m}\text{Tc}]\text{Tc-DPD}$ whole body and SPECT studies. ATTR cardiac amyloidosis is diagnosed on the basis of very high bone-tracer uptake in the heart muscle. AP — anteroposterior; ATTR — transthyretin amyloidosis; DPD — 2,3-dicarboxypropane-1,1-diphosphonate; PA — posteroanterior; SPECT — single photon emission computed tomography

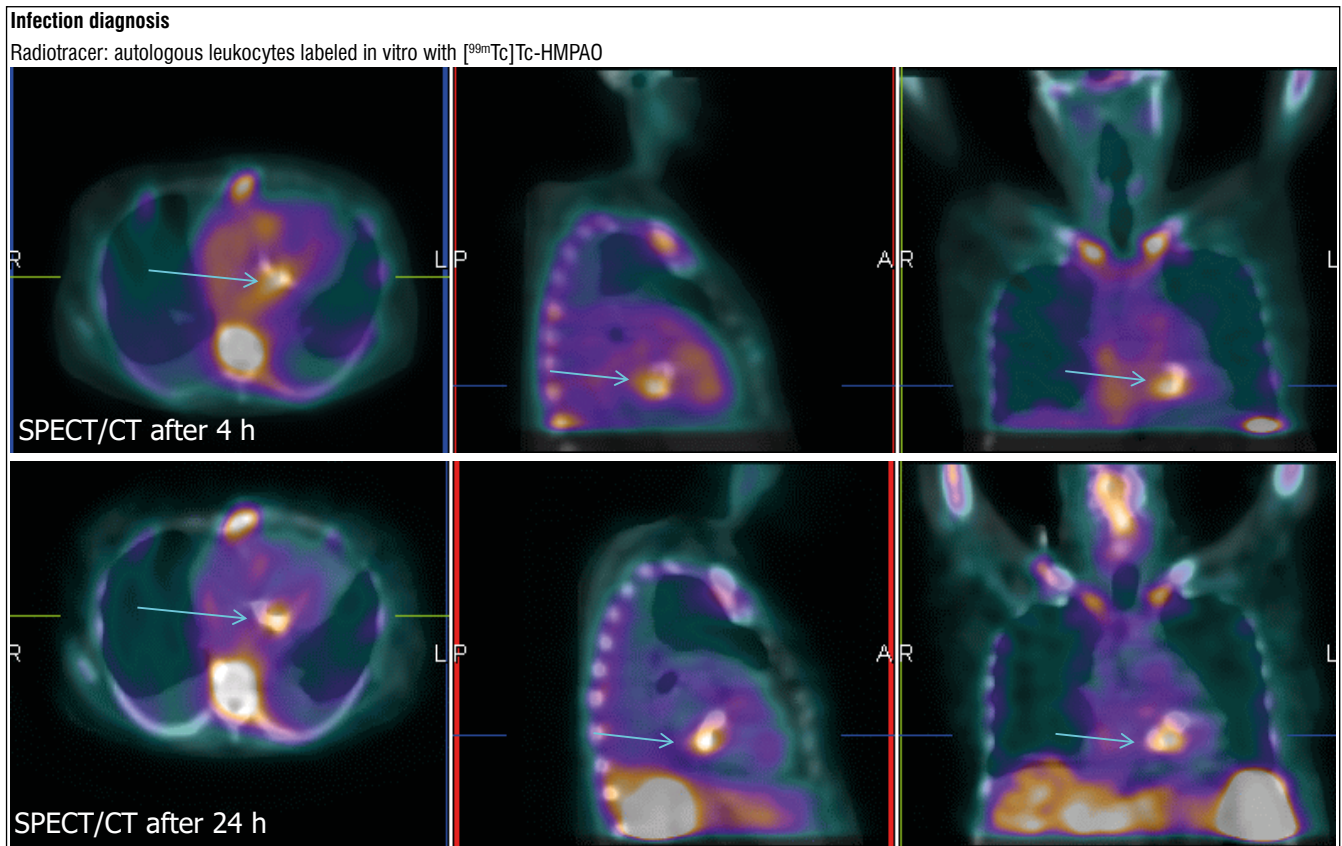


Figure 6. Example of the results of SPECT/CT study with labeled leukocytes in suspected infective endocarditis on a mitral valve prosthesis. Active inflammatory process in the area of the prosthetic valve is diagnosed on the basis of: 1 — lesion of increased accumulation of radiotracer in connection with the valve — in the early (after 4 hours) and late (after 24 hours) examinations, and 2 — increase in the lesion radioactivity during the 20-hour observation period. CT — computed tomography; HMPAO — hexa-methyl-propylene-amine-oxime; SPECT — single photon emission computed tomography

In 2019–2021, 164, 134, and 280 scintigraphic tests for cardiac amyloidosis were performed (0.5%, 0.5%, and 0.9% of all cardiac procedures in each of these years) (Fig. 3). This type of test was carried out in 9 NM departments. Mainly used radiopharmaceutical was [^{99m}Tc]Tc-DPD (246 of 280 studies performed in 2021, whereas [^{99m}Tc]Tc-HDMP was used in 30 studies, and [^{99m}Tc]Tc-PYP in 4 studies) (Fig. 5).

In 2019–2021, diagnostics of inflammation in the chest using leukocytes labeled with technetium ^{99m}Tc were performed in 124, 100, and 124 patients, respectively (below 0.5% of all procedures performed in each of these years) (Fig. 3, 6).

PET cardiology studies

In 2021, the total number of cardiological PET examinations was 269, which was lower than in 2019 (385 studies) (Fig. 2). The most frequently performed cardiological heart examination using the PET technique in 2021 was the diagnosis of inflammation in the chest (166 examinations, i.e. 61.7%), followed by the assessment of cardiac viability (46 examinations, i.e. 17.1%) (Fig. 7). Myocardial perfusion scintigraphy was performed only 15 times at rest and 15 times after vasodilator loading.

Discussion

The survey covers the years 2019–2021. 2019 was a year of normal activity in the field of radioisotope diagnostics, while the

SARS-CoV-2 coronavirus pandemic reached Poland in March 2020 and was lifted on July 1, 2023. The data show that during the first year of the pandemic (2020), the number of radioisotope tests in cardiology decreased by 20%, but in the following year it returned to the pre-pandemic level.

In 2000, there were 7,198 stress NM myocardial perfusion tests performed [13]; in 2021, this number was 16,606. Since this has always been the dominant group of radioisotope heart studies, it can be estimated that the total number of radioisotope tests in cardiology in Poland has increased 2.3 times over the last 20 years.

Scintigraphy for cardiac amyloidosis type ATTR was introduced in Poland in 2018, after the announcement of the ESC guidelines on hypertrophic cardiomyopathy in 2014 [14], and after a non-invasive algorithm for cardiac amyloidosis development by Gilmore in 2016 [10]. The number of scintigraphic tests for cardiac amyloidosis increases (280 studies in 2021). In suspected ATTR, in the guidelines of 2014, it was recommended to consider scintigraphy using bone markers (recommendation class IIa). Since 2023, in the new ESC guidelines, scintigraphy using bone markers is recommended (recommendation class I) [8].

Chest infection/inflammation tests using nuclear cardiology methods are rare in Poland. Diagnostics of inflammatory conditions is the only test performed using the PET/CT technique more often than the SPECT/CT technique (166 vs. 124 studies in

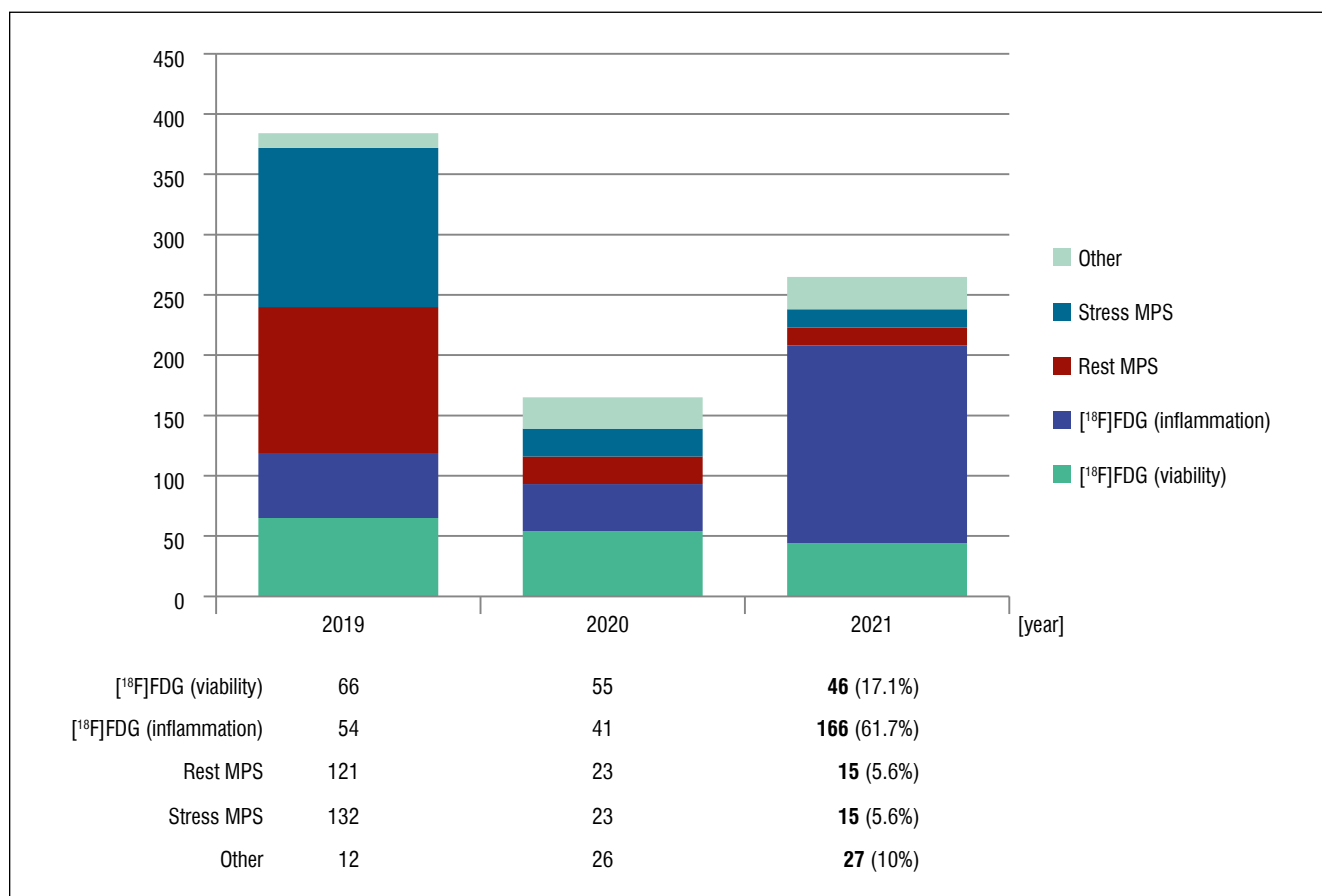


Figure 7. Number and type of PET cardiology studies in 2019–2021. Numbers in brackets indicate the percentage of tests in relation to the total number of PET tests in 2021. FDG — fluoro-2-deoxy-D-glucose; MPS — myocardial perfusion scintigraphy; PET — positron emission tomography

2021). The test is performed mainly in suspected cases of infective endocarditis. SPECT/CT has a specificity close to 100%, but is a difficult technique (requires labeling of autologous leukocytes) and long-lasting (registration of images is performed after several hours and after 24 hours). [¹⁸F]FDG PET is a standard imaging method with a high sensitivity of over 90%.

The total number of cardiological PET examinations has not exceeded 400 in recent years, although the PET technique has unique capabilities compared to SPECT. Above all, it enables quantitative assessment of myocardial blood flow based on measurements of changes in tracer concentration during dynamic acquisition with ⁸²Rb, [¹³N]NH₃, [¹⁵O]H₂O. In clinical practice, however, relative perfusion assessment in PET is most often used, like in SPECT, which can be insufficient in 3-vessel disease or in microcirculatory disease. The reason is the complexity of the required data acquisition and analysis protocols for short-living positron radioisotopes. Possibly, the situation will change with the introduction of a new fluorine ¹⁸F-labeled perfusion tracer [¹⁸F]Flurpiridaz soon.

Conclusions

In Poland, cardiac scintigraphy is performed in 39 classic nuclear medicine centers and in 14 PET centers, using modern

equipment, in approximately 1/1000 inhabitants per year. Polish nuclear cardiology is basically based on classical nuclear medicine. Almost 99% of the tests are stress and rest myocardial perfusion studies. PET has limited practical use (< 1% of studies).

Article information and declarations

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Author contributions

The study conception and design — AT, LK; data collection — AT, LK; figures — AT; draft of the manuscript — AT; revision of the manuscript before submission — LK.

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Conflict of interest

The authors declare no conflict of interest.

Supplementary material

None.

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