Impact of Myocardial Perfusion Imaging with PET and ^{82}Rb on Downstream Invasive Procedure Utilization, Costs, and Outcomes in Coronary Disease Management

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We hypothesized that PET myocardial perfusion imaging with ^{82}Rb (PET MPI), would reduce downstream utilization of diagnostic arteriography, compared with SPECT, in patients matched for pretest likelihood of coronary disease (pCAD). PET MPI is more accurate for assessment of impaired coronary flow reserve compared with SPECT MPI, potentially reducing the demand for subsequent arteriography, percutaneous transcoronary intervention, and coronary artery bypass grafting (CABG), with attendant cost savings, while avoiding a negative impact on coronary events. **Methods:** The frequency of diagnostic arteriography, revascularization, costs, and 1-y clinical outcomes in 2,159 patients studied with PET MPI was compared with 2 control groups studied with SPECT MPI matched to the PET group by pCAD: an internal control group of 102 patients and an external SPECT control group of 5,826 patients. CAD management costs were approximated with realistic global fee estimates. **Results:** Arteriography rates were 0.34 and 0.31 for the external and internal control SPECT groups and 0.13 for the patients studied with PET ($P < 0.0001$). pCAD averaged 0.39 in patients studied with PET MPI, and in the external SPECT control group, and 0.37 in the internal SPECT controls. Revascularization rates were 0.13 and 0.11 for external and internal SPECT patients and 0.06 for the PET group ($P < 0.0001$; $P < 0.01$), with a cost savings of 30% noted for PET patients, with no significant difference in cardiac death or myocardial infaction at 1-y follow-up. **Conclusion:** PET MPI in patients with intermediate pCAD results in a >50% reduction in invasive coronary arteriography and CABG, a 30% cost savings, and excellent clinical outcomes at 1 y compared with SPECT.

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Compelling evidence has demonstrated that invasive procedures such as coronary arteriography, coronary artery bypass grafting (CABG), and percutaneous transcoronary intervention (PTCI) are overutilized in the United States, contributing to unnecessary health care expense without improved patient outcomes (*1–6*). Management of coronary disease (CAD) currently utilizes noninvasive diagnostic testing as a "gatekeeper," which typically provokes invasive coronary arteriography when results are abnormal, to provide a definitive diagnosis of CAD. Thereafter, mechanical myocardial revascularization is usually performed on the basis of the coronary lumenogram, often without improved outcome—specifically in the hard endpoints of coronary death and myocardial infarction (MI)—despite great cost (*7*). Previous theoretic models have indicated that increased diagnostic accuracy of noninvasive testing, specifically myocardial perfusion imaging using PET (PET MPI), may reduce costs and improve outcomes when used in place of SPECT (SPECT MPI), in the routine management of CAD (*8,9*), however, documentation of this hypothesis in a prospective trial has not been previously reported.

This study tests the hypothesis that a noninvasive strategy for CAD management using MPI, free of attenuation artifacts with improved resolution and image contrast due to substantially higher counts provided by PET, lowers costs of CAD management, through reduction of unnecessary downstream invasive diagnostic and therapeutic procedures, compared with conventional management with standard exercise SPECT, because of the improvement in diagnostic accuracy provided by PET.

In this study, clinical outcomes, procedure utilization, and costs were evaluated in 2,159 sequential patients imaged with PET MPI and compared with 2 control groups of patients, matched for pretest likelihood of CAD (pCAD), who were imaged with SPECT MPI.

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MATERIALS AND METHODS

Study Design

Immediately after the addition of a PET camera in the outpatient nuclear cardiology department of a large referral practice consisting of 20 cardiologists (both invasive and noninvasive), all patients referred for MPI underwent prospective calculation of pretest probability of CAD, using commercially available software (CADENZA; Advanced Heuristics). This program determines the pretest likelihood of coronary disease or active myocardial ischemia, in patients with known CAD (pCAD), by incorporating patient demographics, risk factors, symptomatic status, and exercise electrocardiography study results if performed; pCAD is determined by comparison with published epidemiologic data (*10*). Patients were assigned to diagnostic testing on the basis of their pCAD using the algorithm shown in Table 1.

After assessment of the average pCAD of an initial cohort of 102 patients referred to PET MPI, a control group of 102 patients studied with SPECT MPI was matched for pCAD to the PET patients, identified with CADENZA from patients studied within 1 y before installation of the PET camera (internal SPECT control group). Clinical outcomes and procedure utilization in all patients were tracked through chart review and standardized telephone interviews. Costs of diagnosis and subsequent myocardial revascularization were then calculated using estimated global national charges shown in Table 2. An additional external control group studied with SPECT MPI, who underwent independent assessment of pCAD, was identified. This group was comprised of 5,826 patients studied with SPECT MPI in the END trial (*11*)—the largest multicenter trial of patients studied with SPECT and followed for subsequent utilization of invasive cardiac procedures that has been published. This group had a mean pCAD of 0.39, identical to the patients in this study imaged with PET.

Imaging Protocols

All patients signed informed consent, acknowledging and accepting the risks of either exercise or pharmacologic stress and agreeing to subsequent follow-up, with their anonymity preserved.

Exercise SPECT Protocol. Patients who underwent exercise SPECT had continuous, graded treadmill testing to the usual clinical endpoints of fatigue, accelerating angina, hypotension, or important ST depression. At peak exercise, 740–1,110 MBq (20–30 mCi) of ^{99m}Tc-sestamibi were injected intravenously and the patient continued to exercise, if possible, for 60–90 s after injection. SPECT began 30–45 min later on a dual-head fixed 90° γ-camera (CardiaL; ElScint) using a 64 × 64 matrix, 120-frames (60 stops), 30 s per frame with a low-energy general-purpose collimator, which typically resulted in the accumulation of 1–1.5 million counts in the SPECT image. Rest images were acquired, in general, the day after stress imaging, 45 min after injection of sestamibi using the same dose as that used during the exercise study. Processing was performed with a Butterworth filter, order 4.16, followed by filtered backprojection. Rest and stress images were reconstructed into 6.9-mm short-axis, horizontal, and vertical long-axis slices. All rest and stress images were also reconstructed for gated and 3-dimensional evaluation; gated images were acquired at 16-frames per second.

Images were reviewed immediately for adequate diagnostic technical quality and read subsequently by 1 of 3 nuclear cardiologists who were board certified in nuclear cardiology and were unaware of clinical data. If images were deemed technically inadequate, the patient was reimaged (e.g., with longer acquisition time). Clinical correlation was then made in the final nuclear report, in view of the patient's exercise performance, stress electrocardiography (ECG) tracings, and clinical record. Coronary angiography was not specifically recommended in the report unless the patient had clearly high-risk features of ischemia, such as multiple reversible perfusion defects, transient ischemic dilatation, or a very large ischemic burden (e.g., >20% of total left ventricular mass).

Pharmacologic Stress PET Protocol. PET was performed with a Posicam HZL/R camera (Positron Corp.) containing 4,096 bismuth germanium oxide detectors with a ratio of crystal to photomultiplier tube of 4:1 and an axial field of view of 15.6 cm. The system sensitivity is 260,000 counts/s/μCi/mL, with a 5.8-mm isotropic resolution, producing sixty-one 2.6-mm slices (*12*). After positioning in the PET camera, patients were injected with 1,850–2,960 MBq (50–80 mCi) of ^{82}Rb eluted from the commercially available semiautomated desktop ^{82}Sr generator (Bracco Diagnostics) using the rubidium infusion system (CTI). Image acquisition was begun 70 s after completion of the ^{82}Rb infusion to allow clearance from the lungs and blood pool and continued for 7 min. This typically resulted in the accumulation of 20–45 million true counts on the emission image. PET images were then reconstructed using filtered backprojection with a Butterworth filter, order 5.04. The nonattenuation-corrected rest myocardial perfusion image was then used to confirm patient positioning in the center of the field of view. In those few cases in which myocardium was excluded from the field of view, the patient was repositioned and the rest study was repeated. After confirmation of

TABLE 1
Diagnostic Algorithm Used to Identify Patients Suitable for Direct PET MPI on the Basis of Their Pretest Likelihood of CAD or Ischemia (pCAD)

pCAD	Diagnostic test
0–10	Reassurance or treadmill electrocardiography
11–70	Stress PET MPI
71–89	Stress SPECT MPI
90–100	Direct coronary angiography

Only patients with moderate pCAD (0.11–0.70) were routed to PET MPI as initially suggested by the econometric model of Patterson et al. (*8*). Patients with pCAD < 0.11 or > 0.70 were excluded from the study.

TABLE 2
Estimated Global Charges for CAD Diagnostic Tests

Test	Global charge ($)
Exercise treadmill ECG	300
SPECT with exercise treadmill ECG	1,000
PET with pharmacologic stress	1,850
Coronary angiography	4,800
PTCI	10,000
CABG	40,000

ECG = electrocardiography.

proper positioning, the patient's position was marked on the thorax within the PET gantry using low-intensity lasers mounted on the camera.

Transmission imaging commenced immediately with a 150-MBq (4 mCi) ^{68}Ge rod mounted on a circular track within the PET camera, which circled the patient over 20–30 min until 120–150 million counts were obtained in the transmission image.

Immediately thereafter, pharmacologic stress intravenous infusion was performed using dipyridamole (0.57 mg/kg over 4 min), adenosine (0.146 μg/kg over 5 min), or dobutamine (to a maximum dose of 40 μg/kg/min). Dipyridamole or adenosine was used unless contraindicated because of clinical factors such as theophylline or oral dipyridamole use. The rubidium infusion was repeated using the rest study dose, 4 min after dipyridamole infusion, 2 min 30 s after adenosine was begun, or 3 min after achieving the maximal dobutamine dose. PET stress image acquisition was then performed over 7 min, beginning 70 s after the end of the rubidium infusion, with subsequent image processing identical to that used for the rest study.

Rest and pharmacologic stress PET images were then corrected for tissue attenuation, dead-time losses, scatter and randoms, as well as patient motion in the camera. Corrected image sets were oriented into short-axis, vertical, and horizontal long-axis tomographic slices as well as polar and Mercator projection images. A single experienced PET nuclear cardiologist read images unaware of clinical data, with a clinical correlation made in the nuclear report analogous to the process used for reporting SPECT data as outlined.

Coronary arteriography was explicitly recommended for PET patients only if a large (defined as >20% of total left ventricular mass), severe stress-induced perfusion defect was identified or there was transient ischemic dilatation or multiple perfusion defects, comparable to the SPECT criteria. The final decision to proceed with coronary arteriography was made by the referring physician (and patient), on the basis of all relevant clinical data, including, but not limited to, the nuclear MPI study in all patients.

Patient Follow-up

After generation of the PET MPI report and its incorporation into the clinical record, follow-up was begun every 3 mo—on all patients studied with PET as well as on the SPECT internal control group—using each patient's medical record as updated during return clinic visits or telephone follow-up as necessary.

Cost Calculations

Costs were calculated by multiplying the number of patients undergoing a given procedure by the test fee and summing that for all patients tested. Test fees were based on estimated global charges, which included both technical and professional components as shown in Table 2.

Statistics

The statistical significance for comparing proportions was determined using the z statistic based on the normal approximation to the binomial distribution (*13*). A P value ≤ 0.05 was considered significant.

RESULTS

A total of 2,159 patients were routed to PET MPI, on the basis of their calculated pCAD, using the algorithm shown in Table 1. Follow-up for procedure utilization and cardiac events were completed on all internal control SPECT patients and in 95.8% of the patients studied with PET MPI over a mean follow-up of 12.4 mo.

Patient demographics and pCAD in patients studied with SPECT and PET MPI are shown in Table 3. The average age of the study population was 65.7 y, and 46% of the patients were women. Approximately half of patients in the PET and SPECT groups had a known history of CAD.

Indications for the study of the SPECT and PET groups are shown in Table 4. The most common indication for study in the SPECT and PET groups was assessment of chest pain, with or without prior revascularization. Nuclear cardiology studies were frequently requested in asymptomatic patients with and without known CAD for risk stratification before proposed major noncardiac surgery. Resolution of an equivocal exercise SPECT study, or one discordant with ECG or clinical findings, was an indication for PET.

The pCAD in the 102 patient SPECT internal control group assessed with CADENZA was 0.37; in the 5,826 patients reported in the END study imaged with SPECT, pCAD was 0.39. In the 2,159 patients studied with PET MPI, pCAD was also 0.39.

Figure 1 shows utilization of coronary arteriography in the SPECT and the PET groups. Diagnostic coronary arteriography was performed in 31.4% and 34% of patients studied with SPECT (internal and external controls, respectively) and in 13% of those studied with PET.

The decision to proceed to coronary arteriography was made by the referring physician in both SPECT and PET patients after review of the MPI report, stress test results, and clinical circumstances. The >50% reduction in coronary angiography rates in patients studied with PET MPI compared with those studied with SPECT was highly statistically significant ($P < 0.0001$), despite the difference in the number of patients in the PET and the internal SPECT control groups ($n = 2{,}159$ vs. $n = 102$, respectively). This

TABLE 3
Patient Demographics and pCAD in Subgroups in the Internal SPECT Control Group and PET Group with Known [(+) CAD] vs. Suspected [(?) CAD] CAD Status Before Testing

Patient demographics	SPECT*	PET*
Patients (*n*)	102	2,159
Median age (y)	62 ± 11	66 ± 8
Male (*n*)	55 (54)	1,166 (54)
Female (*n*)	47 (46)	993 (46)
Known (+)CAD (*n*)	45 (44)	1,058 (49)
pCAD: + CAD	0.461 ± 0.05	0.474 ± 0.15
Possible (?) CAD (*n*)	57 (56)	1,101 (51)
pCAD: ?CAD	0.291 ± 0.14	0.333 ± 0.10

*Values in parentheses are percentages.

SPECT vs. PET groups are well matched for sex and proportion of patients with known CAD.

TABLE 4
Indications for Study with SPECT or PET MPI

Indication	%
Chest pain	53
Dyspnea on exertion	18
Abnormal SPECT/ECHO	9
S/P coronary revascularization	7
Resolution of equivocal SPECT	7
Other	6

S/P = status post; ECHO= echocardiography.

change was even more significant when PET patients were compared with the SPECT patients reported in the END study with equivalent pCAD ($P < 0.00001$).

The decreased frequency of false-positive myocardial perfusion studies for the presence of CAD, as indicated by coronary arteriography, was also statistically significant ($P < 0.0001$), reduced by two-thirds from 15.6% for patients studied with SPECT MPI to 5.2% for those studied with PET MPI (Fig. 1), confirming the improved specificity of PET MPI, as previously reported (*14*).

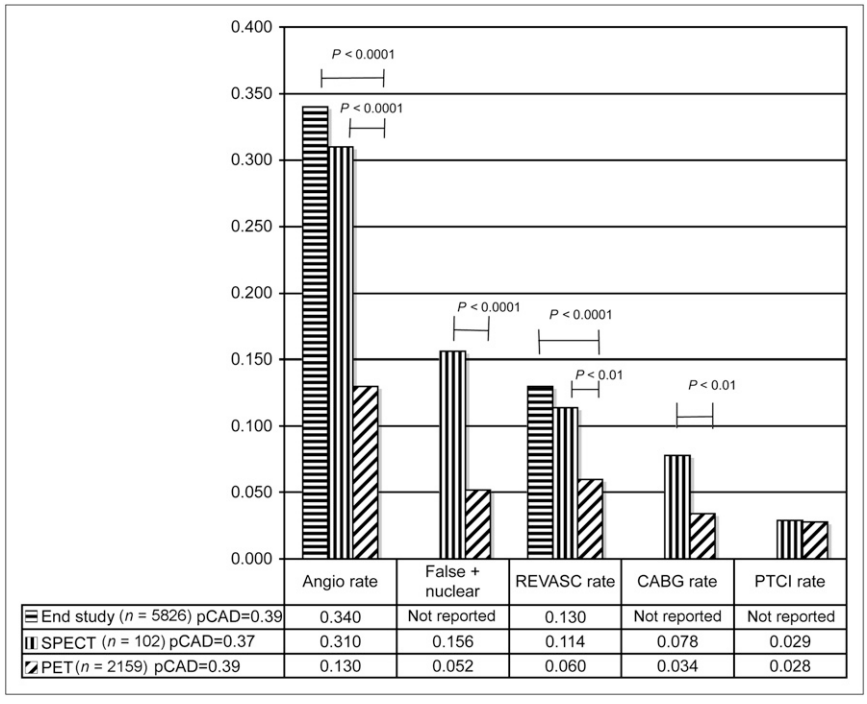
Utilization of revascularization procedures is also shown in Figure 1. CABG was reduced significantly, by 50%, in the patients studied with PET MPI compared with the SPECT MPI groups ($P < 0.01$). This reduction in CABG procedures associated with PET-guided management paralleled the decreased utilization of coronary angiography. The frequency of CABG after angiography (approximately 25%), was similar in both the SPECT and PET groups, demonstrating that the reduction in CABG with PET is directly attributable to the reduced utilization of angiography, in these patients who were matched for pCAD. There was no difference in the rate of PTCI between the PET and SPECT control groups.

Cardiac event rates in the SPECT and PET patients are shown in Figure 2. Acute MI and coronary mortality at 1-y follow-up were seen less frequently in patients managed with PET compared with the internal SPECT control group, though this did not reach statistical significance. Individual case review demonstrated that early mortality was associated with the complications of CABG in both the SPECT and PET groups.

Direct procedure costs for diagnostic testing and revascularization procedures are shown in Figure 3, without considering additional costs (direct and indirect) associated with CAD management, such as hospitalization and treatment of complications associated with invasive procedures, loss of money due to time off from work, or disability disbursements.

The cost of diagnostic testing was essentially equal at approximately $2,500 per patient whether SPECT or PET MPI was used. The cost advantage of the lower fee for SPECT MPI ($1,000) was lost, when compared with PET MPI ($1,850), because of the use of additional coronary arteriography procedures compared with PET. PET MPI appeared to be sufficiently diagnostic, to obviate the need for invasive coronary arteriography to clarify the diagnosis of CAD. Thus, the cost of CAD diagnosis with PET MPI is "cost neutral" compared with SPECT.

Whereas diagnostically PET and SPECT are cost neutral, a 52% savings was seen in revascularization costs with PET when compared with SPECT because of the reduction in



	Angio rate	False + nuclear	REVASC rate	CABG rate	PTCI rate
End study (*n* = 5826) pCAD=0.39	0.340	Not reported	0.130	Not reported	Not reported
SPECT (*n* = 102) pCAD=0.37	0.310	0.156	0.114	0.078	0.029
PET (*n* = 2159) pCAD=0.39	0.130	0.052	0.060	0.034	0.028

FIGURE 1. Utilization rates of diagnostic coronary arteriography (Angio), PTCI, and CABG in patients studied with SPECT vs. PET MPI. REVASC = revascularization.

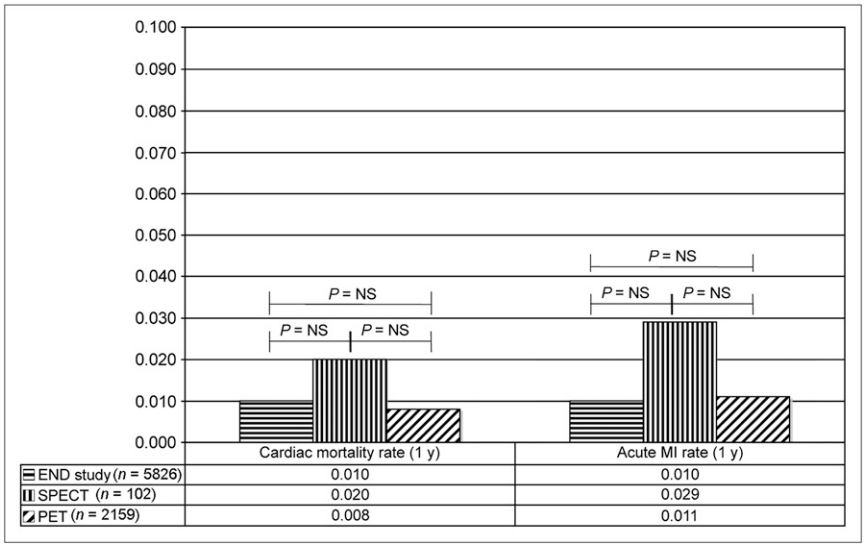


FIGURE 2. Clinical outcomes at average 1-y follow-up in patients studied with SPECT vs. PET MPI. NS = not statistically significant.

CABG utilization. Total costs of CAD management were reduced by approximately 30% when PET MPI was used routinely compared with SPECT. These savings occurred without adverse clinical outcomes, as demonstrated in Figures 2 and 3.

DISCUSSION

SPECT MPI is less accurate than PET MPI, primarily because of poor specificity, especially in women and overweight patients (*15–18*) (Fig. 4). In a meta-analysis of 44 studies published between January 1990 and October 1997, the sensitivity of exercise SPECT was found to be 87% (95% confidence interval [CI], 86%–88%) with specificity of 64% (95% CI, 60%–68%) (*19*). In contrast, both sensitivity and specificity of CAD detection with PET is at least 95% in populations with an intermediate pCAD (*20–24*). This is due largely to high-energy-photon coincidence detection, attenuation correction, a doubling of image resolution to 10-mm full width at half maximum for cardiac PET, which is depth independent, and markedly improved image contrast associated with 20–30 times as many acquired counts in PET compared with SPECT images.

Recently, Bateman et al. demonstrated "...in a large population of (pCAD) matched pharmacologic stress patients, myocardial perfusion PET was superior to SPECT in image quality, interpretive certainty, and diagnostic accuracy". "This was true in men and women, in obese and nonobese patients and for correct identification of multivessel coronary disease" (*25*).

Our study in a high-volume, cardiology practice of both noninvasive and invasive cardiologists with both SPECT and PET capability, confirms these findings and demonstrates that PET MPI, when used as a routine, first-line approach in the management of CAD in patients with intermediate pCAD, is more cost-effective than SPECT

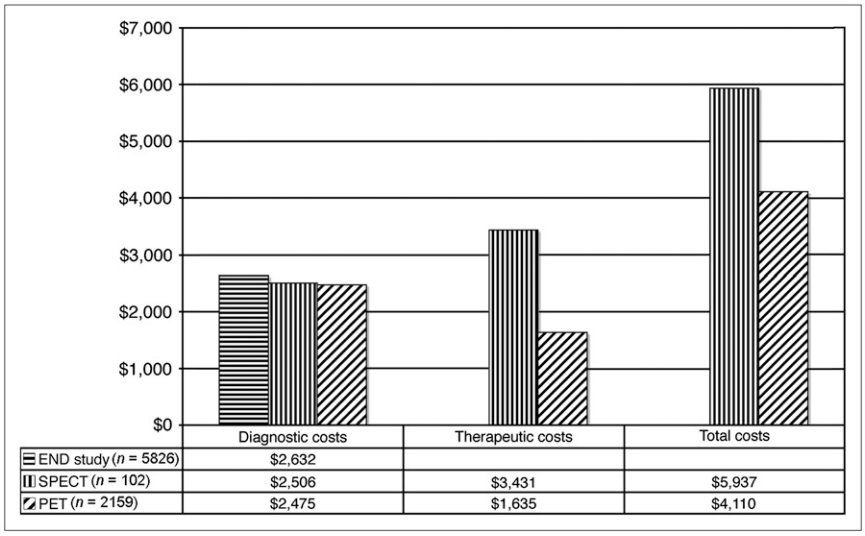


FIGURE 3. CAD management costs in patients studied with SPECT vs. PET MPI.

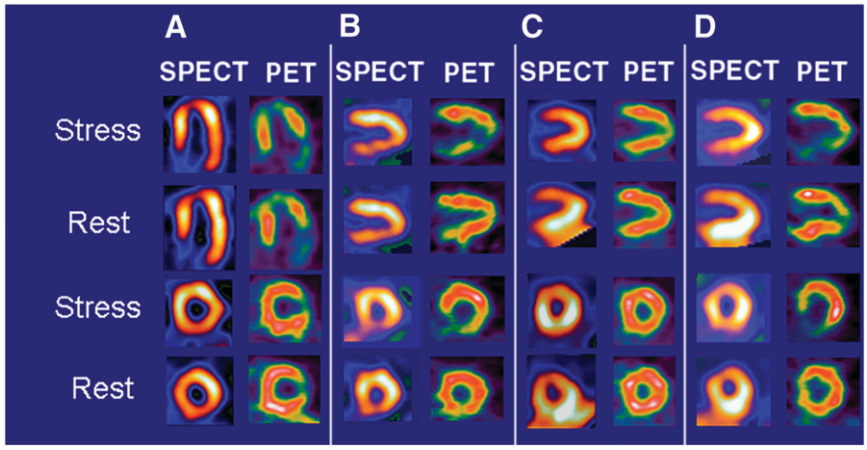


FIGURE 4. Examples of improved diagnostic reliability of PET vs. SPECT MPI in the same patients. (A) A 70-y-old man status post CABG with no history of MI. Exercise/rest SPECT images are normal but left ventricular ejection fraction was surprisingly reduced at 0.39. PET MPI within 2 wk discloses a clinically occult posterobasal MI. (B) A 53-y-old man with exertional left arm pain. SPECT images with dipyridamole stress are normal. PET MPI within 2 wk demonstrates a reversible inferoseptal perfusion defect. Ninety percent circumflex stenosis found on coronary arteriography. (C) A 46-y-old woman with chest pain. SPECT images are equivocal for reversible ischemia in inferolateral wall. PET images are normal. (D) A 59-y-old woman with chest pain. SPECT images are equivocal for reversible inferolateral ischemia as in C. PET images demonstrate reversible inferoseptal perfusion defect, treated with PTCI of 95% dominant right coronary artery stenosis.

MPI. This is because PET MPI reduces utilization of downstream coronary arteriography and CABG by 50%. This results in a 30% reduction in total disease management costs and no deleterious short-term clinical outcome, when compared with the current approach using exercise SPECT.

Emergence of PET MPI for Routine Clinical Use

The published literature acknowledges the technical advantages of PET MPI compared with SPECT (*8,9,14,26–29*) but lacks documentation of the hypothesized, associated clinical benefits compared with SPECT. In 1995, the American College of Cardiology, American Heart Association, and American Society of Nuclear Cardiology reclassified PET MPI from a research modality to a "Class 1" procedure appropriate for routine clinical use as is SPECT MPI (*26*).

To our knowledge, the present study is the first to demonstrate that the improved accuracy of PET leads to total cost savings in CAD management in clinical practice, by eliminating unnecessary diagnostic and therapeutic procedures—namely, coronary arteriography and CABG.

Gould was the first to suggest that PET MPI could reduce the cost of medical management of CAD compared with SPECT due to increased test accuracy (*30*). Subsequently, Patterson et al. presented an econometric model that compared the cost-effectiveness and utility of 4 clinical algorithms for the diagnosis of CAD: treadmill electrocardiography, SPECT MPI, PET MPI, and direct coronary arteriography (*8*). However, neither study reported data from a clinical trial.

In the present study, we prospectively tested the predictions of the econometric model of Patterson et al., by rigorously assessing pCAD before assigning patients to PET MPI and comparing disease management costs to 2 matched groups studied with SPECT. Our results demonstrate a marked reduction in CAD management costs with improved patient outcomes, consistent with the predictions of the Patterson model.

More recently, the Patterson model has been extended to include stress echocardiography and has been subjected to additional sensitivity analysis in which Medicare reimbursement rates are used in place of "customary" test fees (*9*). The results did not change: PET MPI was identified to be the most cost-effective test for patients with a 10%–70% pCAD.

Comparison with Previous Studies

To our knowledge, this is the first clinical study to examine the cost efficacy of PET MPI compared with SPECT MPI in a population matched for pCAD. The overall rate of coronary angiography in our SPECT control group was 31.4%, appropriate for a population with a pretest likelihood of CAD or ischemia of 37%.

The scant literature that has examined angiographic rates after SPECT MPI shows that, in general, referral for coronary angiography does parallel the pCAD: Angiography rates of 17%–50% are reported for patients with an intermediate likelihood of CAD (*11,16,31,32*). Importantly, in the few studies that report subsequent myocardial revascularization rates, the frequency of revascularization increases directly with the increased utilization of coronary arteriography, independent of other clinical factors. For example, a recent, large prospective randomized, multicenter study compared a strategy of direct coronary angiography (n = 5,423) with assignment to SPECT MPI with subsequent coronary angiography based on the SPECT results (n = 5,823). (*11*). The utilization of subsequent revascularization was essentially doubled with the direct coronary arteriography strategy.

The 31% rate of coronary arteriography after SPECT and the 25% utilization rate of CABG after angiography in our study are similar to these rates in other reports. Nallamothu et al. found an angiography rate of 29% after exercise SPECT and a 30% rate of subsequent revascularization within 3 mo of coronary arteriography guided by adenosine SPECT MPI. (*31,32*).

Limitations

The design of this study was a prospective, sequential analysis of patients referred to an outpatient nuclear cardiology laboratory with both SPECT and PET capabilities, who were routed to PET MPI on the basis of objective assessment of pretest disease likelihood. Over the 2 y of the study, practice and referral patterns changed as experience with PET accumulated. In recognition of this, the SPECT control group was specifically chosen from patients imaged within 1 y before installation of the PET camera and evaluated retrospectively with all of the limitations of such an analysis. The advantage of this methodology, however, is that referral bias due to the presence of the PET camera was eliminated.

The 102 SPECT internal control patients were objectively well matched for pretest disease likelihood to the first 102 PET patients, although additional SPECT patients could have been analyzed to match the total number in the PET population. This appeared redundant, however, after the publication of data from the Economics of Noninvasive Diagnosis (END) trial (*11*), in which 5,423 patients matched for pCAD were referred for direct coronary arteriography, compared with 5,826 patients undergoing stress SPECT MPI at 6 of the premiere nuclear cardiology laboratories in the United States. In patients who were matched for intermediate pCAD, the rate of subsequent coronary arteriography in the SPECT MPI patients was 34%, strikingly similar to that observed in the SPECT internal control group of the present study (31.4%). Importantly, subsequent myocardial revascularization rates were doubled in the group with intermediate pCAD, managed with direct coronary arteriography, with a 25% increase in CAD management costs, whereas cardiac death and MI rates of 5% at 3-y follow-up were no different with the invasive strategy (*11*) These clinical results parallel those seen in our SPECT control group.

There is wide variability in procedure charges across the country: Exercise electrocardiography with SPECT is reimbursed at approximately $1,000 in Buffalo, New York. The charges we used matched the procedure costs used in the Patterson and Eisner econometric model, which was found to be robust by sensitivity analysis to variable test fees (*9*). Our procedure costs are realistic and compare well with published values (*33–36*), reflecting actual local charges and reimbursement rates in our geographic area, which are typically lower in upstate New York compared with most other parts of the country. Procedure charges were also confirmed by review of bills brought into the clinic by patients interviewed in the follow-up process. Total diagnostic costs for PET and SPECT MPI, and subsequent coronary arteriography, were also similar to our reported data when Ohio Medicare reimbursement rates were substituted in the econometric Patterson model (*9*).

Finally, it could be argued that a randomized study design might be the best way to compare the performance of SPECT MPI versus PET MPI; however, such a study design is no longer feasible, since approval by the Centers for Medicare and Medicaid Services (CMS) for reimbursement for PET MPI in 1995. The principle of informed consent requires informing prospective patients for randomization that SPECT MPI is best done with a 2-d imaging protocol (about 4 h) and carries a 10-fold higher radiation exposure than the 45-min PET procedure. PET has been reported to be more accurate than SPECT, and preliminary data have been published suggesting that the increased accuracy of PET MPI over SPECT reduces the need for subsequent coronary angiography and CABG (*37*). It is unlikely that fully informed patients will enroll in a randomized trial, when they can instead request a more accurate, shorter imaging procedure, which carries one tenth of the radiation burden—that is, PET MPI, which is reimbursed by their insurance carrier.

CONCLUSION

This study demonstrates that PET MPI in clinical practice is a cost-effective method currently available for CAD management as predicted by previous econometric modeling studies. In patients carefully selected for intermediate pCAD, PET MPI results in a 50% reduction in the use of coronary arteriography and CABG, a 30% reduction in CAD management costs, and excellent short-term patient outcomes, compared with conventional practice using SPECT MPI.

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