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EACVI survey on investigations and imaging modalities in chronic coronary syndromes

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Aims The European Association of Cardiovascular Imaging (EACVI) Scientific Initiatives Committee performed a global survey to evaluate current practice for the assessment and management of patients with suspected and confirmed chronic coronary syndromes.

Methods and results One-hundred and ten imaging centres from 37 countries across the world responded to the survey. Most non-invasive investigations for coronary artery disease were widely available, except cardiovascular magnetic resonance (available 40% centres). Coronary computed tomography angiography (CCTA) and nuclear scans were reported by a multi-disciplinary team in only a quarter of centres. In the initial assessment of patients presenting with chest pain, only 32% of respondents indicated that they rely on pre-test probability for selecting the optimal imaging test while 31% proceed directly to CCTA. In patients with established coronary artery disease and recurrent chest pain, respondents opted for stress echocardiography (27%) and nuclear stress perfusion scans (26%). In asymptomatic patients with coronary artery disease and an obstructive (>70%) right coronary artery stenosis, 58% of respondents were happy to pursue medical therapy without further testing or intervention. This proportion fell to 29% with left anterior descending artery stenosis and 1% with left main stem obstruction. In asymptomatic patients with evidence of moderate-to-severe myocardial ischaemia (15%), only 18% of respondents would continue medical therapy without further investigation.

Conclusion Despite guidelines recommendations pre-test probability is used to assess patients with suspected coronary artery in a minority of centres, one-third of centres moving directly to CCTA. Clinicians remain reticent to pursue a strategy of optimal medical therapy without further investigation or intervention in patients with controlled symptoms but obstructive coronary artery stenoses or myocardial ischaemia.

Keywords coronary disease • stress testing • CT • survey • EACVI

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Introduction

Non-invasive imaging plays a critical role in the diagnosis, risk stratification, and management of patients with chronic coronary syndromes.[1] Multiple different modalities can be used for patient assessment, including stress echocardiography, coronary computed tomography angiography (CCTA), and stress perfusion imaging using cardiovascular magnetic resonance (CMR), single photon emission tomography (SPECT), and positron emission tomography (PET). However, there are concerns about the availability of these imaging modalities and variation in reporting expertise across centres. The recommended investigations and management of patients with chronic coronary syndromes have been updated in the recent 2019 Guidelines on Chronic Coronary Syndromes [European Society of Cardiology (ESC) Clinical Practice Guidelines].[2] This document aimed to provide clear recommendations, assisting healthcare providers in their clinical decision making when evaluating patients with chronic coronary syndromes. The guidelines include recommendations on the imaging strategies that could be considered for patient assessment and the role of non-invasive imaging in guiding management. Previously the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) trial[3] and more recently the International Study of Comparative Health Effectiveness with Medical and Invasive Approaches (ISCHEMIA) randomized controlled trial have demonstrated that many patients with chronic coronary syndromes can be managed safely with optimal medical therapy alone.[4]

The aim of this survey from the European Association of Cardiovascular Imaging (EACVI) Scientific Initiatives Committee[5–9] was to evaluate current clinical practice in the assessment, investigation, and management of patients with suspected and confirmed chronic coronary syndromes in light of the updated ESC clinical guidelines and the most recent randomized controlled trial data.

Methods

The present survey was conducted by the EACVI Scientific Initiatives Committee from the 30 April to the 1 June 2020 according to published criteria (www.escardio.org/eacvi/surveys).[5–9] Cardiology units in Europe and around the world were invited to complete the easily accessible online survey to describe the contemporary local use of cardiovascular imaging modalities in the assessment of patients with chronic coronary syndromes. The survey was also disseminated via social media. The 22 survey questions were designed based on the recent ESC guidelines on the diagnosis and management of patients with chronic coronary syndrome. A number of questions incorporating clinical vignettes were included to gain a better understanding of the clinical management of challenging scenarios.

Results

In total, 110 centres from 37 different countries responded to the survey. Responding centres were located in: Afghanistan (1), Argentina (1), Austria (1), Belgium (2), Brazil (3), Croatia (1), Egypt (1), France (2) Georgia (1) Germany (3), Greece (2), Hungary (1), India (3), Italy (8), Japan (1), Lebanon (2), Lithuania (2), Malta (1), Mexico (2), Republic of Moldova (1), Nepal (1), Netherlands (2), New Zealand (2), North Macedonia (2), Norway (5), Poland (3), Portugal (1), Russian Federation (1), Saudi Arabia (1), Serbia (5), Slovenia (5), Spain (6), Switzerland (3), Thailand (1), Turkey (2), UK and Northern Ireland (14), and USA (17). The majority of centres were tertiary care hospitals or university centres (72%), followed by secondary care or district hospitals (14%), private hospitals (9%), and primary care centres (5%), *Figure 1*. The vast majority of respondents were cardiologists (90%) and only 2% were radiologists.

Cardiac imaging availability and reporting

The survey found that 96% of responding centres had access to at least one form of non-invasive imaging for coronary artery disease and, for the majority, it was easier to get a non-invasive test (69%) than an invasive coronary angiogram (31%). The majority of responding centres had good access to stress echocardiography (85%), CCTA (82%), and nuclear stress perfusion (SPECT or PET) scans (71%), while stress CMR was only available in 40% (46% CMR availability in European centres and 30% in centres outside Europe) *Figure 1*. Exercise electrocardiogram (ECG) testing was widely available (92%) although nearly half of respondents (46%) either did not find this test useful at all (18%) or only rarely found it useful (28%).

Where available, stress CMR was reported by a multi-disciplinary team in 43% of centres, with this proportion dropping to 28% for CCTA and 27% for cardiovascular SPECT and PET scans (*Figure 1*). Overall cardiologists were involved in reporting CCTA in 44% of centres, CMR in 84% centres, and nuclear SPECT or PET scans in 42% centres.

Investigations in symptomatic patients

In patients presenting for the first time with chest pain, 32% of respondents used a pre-test probability score to decide on the initial diagnostic test, while 31% of respondents moved straight to CCTA as the principal non-invasive test for decision making, 15% chose stress echocardiography, 12% exercise ECG test, 5% nuclear stress perfusion (SPECT or PET), and 4% stress CMR. Only 1% of centres proceeded directly to invasive coronary angiography in the first instance (*Figure 2*).

In patients with established coronary artery disease and recurrent chest pain, stress echocardiography and nuclear stress perfusion (SPECT or PET) scans were the preferred non-invasive tests for decision making in 27% and 26% of respondents, respectively. Invasive coronary angiography was the next preferred option (17%), followed by stress CMR (16%), CCTA (8%), and exercise ECG testing (6%), *Figure 2*.

In patients with previous coronary artery bypass grafting (CABG) and recurrent angina, one-fifth (20%) of responders indicated that they opt for an initial strategy of medical therapy before considering further imaging investigations. The preferred imaging tests in these patients were invasive coronary angiography (28%), CCTA [24%, either in isolation (11%) or in combination with stress imaging (13%)], nuclear stress perfusion (SPECT or PET, 15%), stress echocardiography (7%), and stress CMR (6%).

When patients require an assessment of myocardial viability, CMR was the most commonly used technique (48%), followed by nuclear

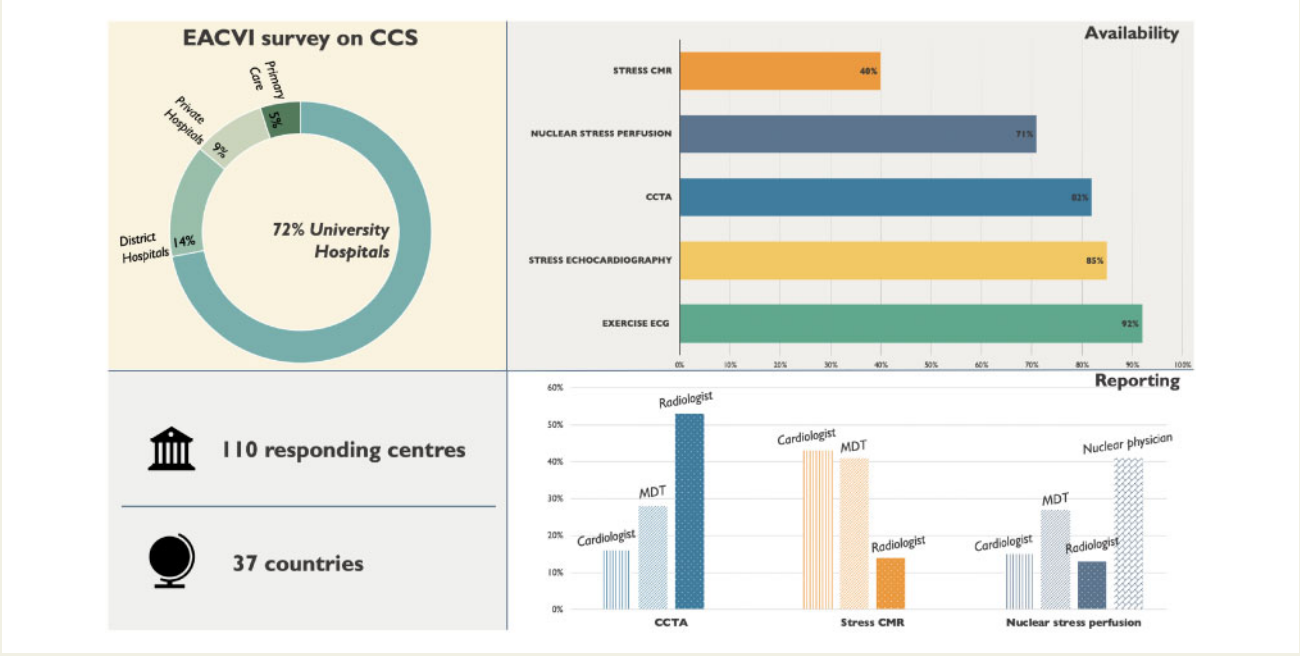

Figure 1 Central illustration summarizing survey findings showing the local availability of non-invasive imagining modalities for coronary artery disease and local reporting of imaging tests. Doughnut chart showing the distribution of responding centres according to hospital setting (72% university hospitals, 14% district hospitals, 9% private hospitals, and 5% primary care). Horizontal bar plot showing the availability of non-invasive tests for coronary artery disease in the responding centres. Vertical bar plot showing the role of the reporting team according to the type of non-invasive coronary imaging technique. CCS, chronic coronary syndromes; CCTA, coronary computed tomography angiography; CMR, cardiovascular magnetic resonance; ECG, electrocardiogram; MDT, multi-disciplinary team.

stress perfusion (SPECT or PET) imaging (22%) and stress echocardiography (16%). Only 1% of respondents would rely on ECG findings to assess viability while just 7% of respondents did not find viability assessment useful in their practice.

Investigations in asymptomatic patients

When screening asymptomatic patients with no history of coronary artery disease, more than half (58%) of survey responders would use a clinical risk score to decide upon a primary prevention strategy. This was either Systemic COronary Risk Evaluation (SCORE, 29% of total number of respondents) or a local cardiovascular risk score (29% of total number of respondents), *Figure 3*. Non-invasive imaging was used to determine primary prevention strategies by 24% of survey respondents: CT calcium scoring (11%), CCTA (6%), stress echocardiography (5%), and stress CMR (2%). The remaining 18% of respondents rely on a combination of imaging and risk scores (*Figure 3*).

In patients who are currently asymptomatic but have an established history of coronary artery disease, the majority of respondents (73%) would not perform routine non-invasive imaging tests but would wait for recurrent symptom development to trigger further imaging. The remainder 27% of respondents would use non-invasive imaging modalities such as stress echocardiography (10%), stress CMR (10%), CCTA (4%), or CT calcium scoring (3%) to track disease progression (*Figure 3*).

Management of coronary artery disease

In asymptomatic patients with an obstructive lesion (defined as >70% stenosis) in the right coronary artery, 58% would continue medical therapy with no further tests, 28% request a stress test, while 12% proceed to invasive coronary angiography and revascularization. In a similar patient with an obstructive lesion in the proximal left anterior descending coronary artery, 29% would continue medical therapy, 36% would request a stress test, and 35% would refer for invasive coronary angiography and revascularization (*Figure 4*). Where an obstructive lesion is found in the left main stem coronary artery on CCTA, 82% indicated that they would refer this patient for invasive coronary angiography and revascularization, while 10% would refer patients straight for CABG and only 1% would continue medical therapy without further investigations (*Figure 4*).

Similarly, in a patient with controlled symptoms and mild reversible ischaemia (8% ischaemic myocardium) in the anterior wall, 61% of survey respondents would continue optimal medical therapy, while one-fifth would perform a CCTA (22%) and 16% would proceed straight to invasive coronary angiography and consider revascularization. In contrast, moderate-to-severe ischaemia on stress myocardial perfusion imaging (15% ischaemic myocardium) in the same patient was an indication for continuing medical therapy in 18% of survey respondents, with the same proportion (18%) opting for CCTA, and 63% proceeding straight to invasive angiography and revascularization (*Figure 4*).

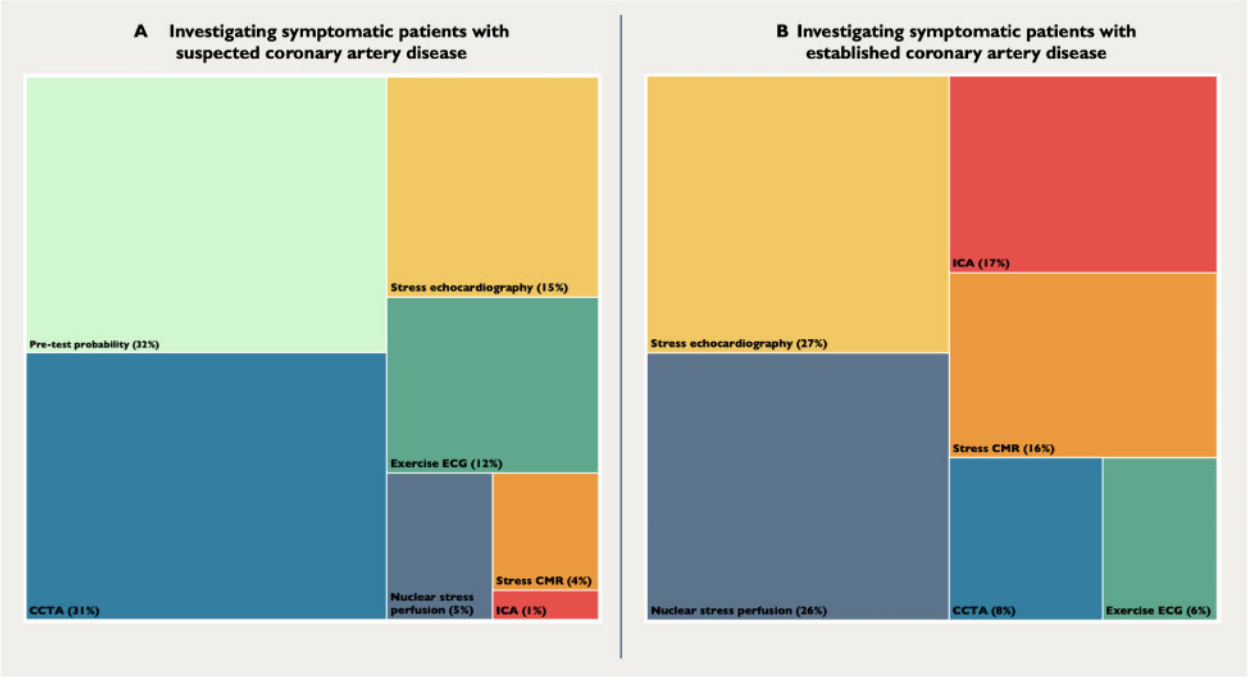

Figure 2 Investigations in symptomatic patients. Panel of two tree plots showing the proportion of different investigations for coronary artery disease in patients presenting with chest pain for the first time (*A*) and for assessing symptomatic patients with known coronary artery disease (*B*). CCTA, coronary computed tomography angiography; CMR, cardiovascular magnetic resonance; ECG, electrocardiogram; ICA, invasive coronary angiography.

Discussion

This global survey provides insight into the contemporary use of cardiac imaging in the assessment and management of patients with suspected and confirmed coronary artery disease.

Cardiac imaging availability and reporting

Encouragingly, most imaging modalities were available in the large majority of centres, except CMR which was available in only 40% of centres, (46% in Europe and 30% in centres outside Europe). The EACVI recommendations on multi-modality imaging supports reporting within a multi-disciplinary team bringing together expertise from cardiologists, radiologists, and nuclear medicine specialists.[10] However, multi-disciplinary reporting of CCTA and stress nuclear scans was only performed in around a quarter of centres. Further work is therefore required to improve the availability of CMR, to improve adequate training,[6] and to encourage the co-reporting of scans by cardiologists, radiologists, and nuclear medicine experts.

Investigations in symptomatic patients

In patients presenting for the first time with chest pain, the 2019 ESC guidelines recommend initial non-invasive assessment before referral for invasive angiography.[2] In this survey, the recommendations were followed in 99% of responding centres. The guidelines also advocate assessment of the pre-test probability of obstructive coronary artery disease before deciding on subsequent investigation steps. Interestingly, the current survey found that only one-third of centres used pre-test probability assessments as recommended. In patients presenting for the first time with chest pain, CCTA was the most used non-invasive imaging technique, following its recent Class I recommendation in the ESC guidelines and reflecting recent randomized controlled trial data.[2,11] Equally, responding centres indicated that exercise ECG testing appears to be less frequently used in clinical practice with half of respondents indicating that they either do not find this test useful at all or only rarely use it in the assessment of patients with suspected coronary artery disease. This reflects a major shift in clinical practice since the previous iteration of the ESC guidelines in 2013 when exercise ECG tolerance testing had a Class I and CCTA a Class IIa indication.[12]

In patients with established coronary artery disease and recurrent angina, stress imaging tests were preferred, with a quarter of respondents using stress echocardiography and a quarter using stress nuclear imaging in this scenario. One-sixth of respondents indicated that they would proceed straight to invasive coronary angiography. These results are broadly consistent with the current ESC guidelines,[2] which emphasize/suggest stress imaging as the preferred initial investigation method with invasive coronary angiography reserved for high risk patients with refractory symptoms.

In patients with previous coronary artery bypass graft surgery and recurrent angina, one-fifth of respondents indicated that they would pursue an initial trial of medical therapy before further investigation. Invasive coronary angiography was the preferred investigation in a

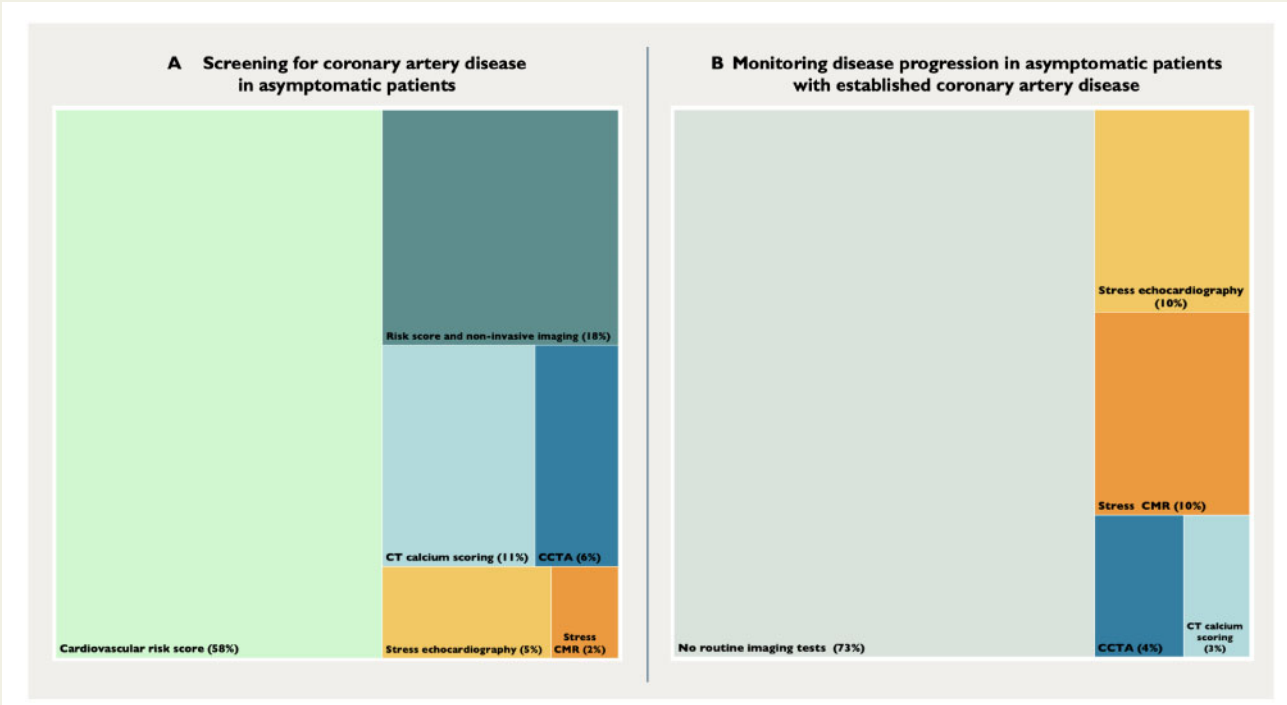

Figure 3 Investigations in asymptomatic patients. Panel of two tree plots showing the distribution of preferred screening modalities for coronary artery disease (*A*) and monitoring disease progression in asymptomatic patients with stable coronary artery disease (*B*). CCTA, coronary computed tomography angiography; CMR, cardiovascular magnetic resonance.

quarter of survey respondents, while a similar proportion preferred CCTA, either in isolation or alongside a functional test. Finally, CMR was the preferred test for assessing myocardial viability, with the majority of respondents still finding viability assessments useful in clinical practice despite the somewhat disappointing results of recent randomized controlled trials.[13]

Investigations in asymptomatic patients

The use of non-invasive imaging in asymptomatic patients is more controversial. In accordance with current guidelines,[2] the majority of respondents use cardiovascular risk scores to guide the prescription of primary prevention intervention. However, 42% of respondents indicated that they employ imaging, either in isolation or alongside risk scores, to guide such decisions. While this proportion is perhaps higher than expected, this strategy is supported by a Class IIb recommendation in the ESC guidelines[2] and requires further systematic evaluation.

Periodic evaluation of symptom control, risk factor management, and medication compliance should be standard practice in asymptomatic patients with established coronary artery disease. However, active monitoring of disease progression with imaging is not recommended in asymptomatic patients. It is therefore perhaps surprising that one quarter of survey respondents use imaging in this way.

Management of coronary artery disease

A key aim of this survey was to evaluate the contemporary management of patients with established chronic coronary syndrome and stabilized symptoms in the light of the ESC guidelines[2] and recent randomized controlled trial data.[4] The clinical scenarios included in this survey involved patients with asymptomatic chronic coronary syndrome and an obstructive coronary lesion (>70%) or evidence of myocardial ischaemia in whom subsequent investigation and management decisions were mainly determined on prognostic grounds. The poor prognosis associated with myocardial ischaemia and obstructive stenoses has long dominated our approach to managing coronary artery disease. The updated ECS guidelines[2] recommend revascularization on prognostic grounds for patients with left main stem disease, patients with reduced left ventricular rejection fraction (LVEF $\leq$ 35%) as a result of coronary artery disease, patients with a major coronary vessel stenosis causing a significant intra-coronary pressure gradient [fractional flow reserve (FFR) $\leq$ 0.80 or instantaneous wave-free ratio (iwFR) $\leq$ 0.89], and in patients with a large ischaemic burden (>10%). Previous evidence from the COURAGE randomized controlled trial[3] and more recently the ISCHEMIA trial[4] demonstrated that revascularization does not reduce the risk of myocardial infarction or death in patients with stable coronary artery disease on optimal medical therapy, even in the presence of moderate-to-severe myocardial ischaemia. The association between myocardial ischaemia and a poor prognosis might not therefore be causal.

This survey demonstrates the ongoing influence of the ischaemia hypothesis in current clinical decision making. In patients with an obstructive right coronary artery lesion or a low ischaemic burden (not considered prognostic in the ESC guidelines) and no ongoing symptoms, only 58–60% of respondents were happy to continue with

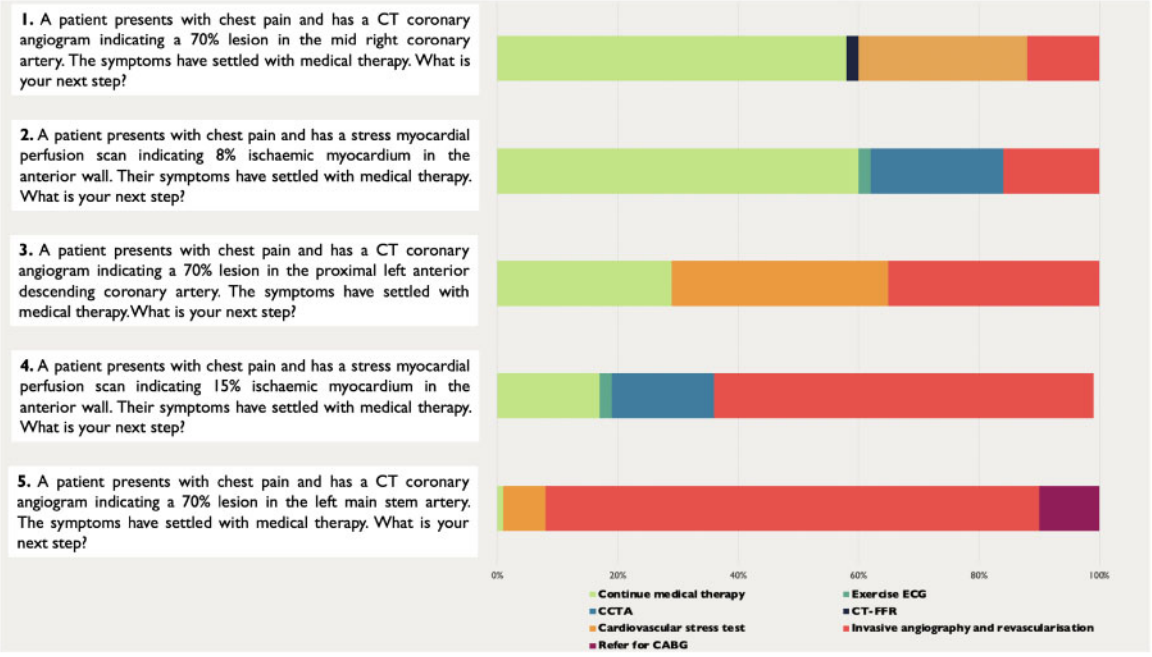

Figure 4 Management of patients with chest pain that resolves with medical therapy. Clinical scenarios and stacked bar charts showing the answers to the clinical question as a proportion of the total number of responses (%). Given the resolution of symptoms, these answers provide insight into which patients clinicians would consider revascularization on prognostic grounds. CABG, coronary artery bypass graft; CCTA, coronary computed tomography angiography; CT-FFR, computed tomography-fractional flow reserve; ECG, electrocardiogram.

medical therapy in the absence of any further tests or investigations. This proportion dropped to 29% in patients with a left anterior descending artery stenosis, suggesting that clinicians remain wary of treating such patients conservatively. As the most recent results of the ISCHEMIA trial continue to be evaluated and discussed, it will be interesting to determine whether these attitudes change with time, and the amount of downstream testing reduces. There was almost universal agreement that patients with left main stem stenoses should be revascularized on prognostic grounds, which is consistent with both the guidelines and the exclusion of such patients from the ISCHEMIA trial.[4]

Limitations

The overall number of survey respondents is relatively low, and the majority worked in tertiary care centres or university hospitals. The survey findings may therefore not be generalizable to other care environments. The majority of survey respondents were cardiologists, and therefore information on imaging practices and reporting may be incomplete. Finally, there are differences between ESC and local national guidelines, which may have influenced the survey responses.

Conclusions

Pre-test probability for coronary artery disease is seldomly used in clinical practice despite guideline recommendations. There is an observed increasing trend in the use of non-invasive anatomical coronary imaging (CCTA) to investigate patients with suspected coronary artery disease, while stress testing remains the preferred modality in patients with established coronary disease and recurrent symptoms. In contemporary practice there remains significant variation in the investigation and management of asymptomatic patients with chronic coronary syndrome who have obstructive coronary artery stenosis or myocardial ischaemia, in spite of repeated trial evidence demonstrating the excellent clinical outcomes of patients treated with optimal medical therapy alone.

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Conflict of interest: None declared.

Data availability

The data underlying this article will be shared on reasonable request to the corresponding author and the EACVI.

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