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European survey on acute coronary syndrome diagnosis and revascularisation treatment: Assessing differences in reported clinical practice with a focus on strategies for specific patient cases

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Abstract

Rationale, Aims, and Objectives: While different imaging and treatment options are available in acute coronary syndrome (ACS) care, there is a lack of data regarding their use across Europe. We examined the diagnostic and treatment strategies in patients with known or suspected ACS as reported by physicians and identified variations in responses across European countries and geographical areas.

Method: A web-based clinician survey focusing on ACS imaging and revascularization treatments was circulated through email distribution lists and websites of European professional societies in the field of cardiology. We collected information on respondents' clinical setting and specialty. Reported percentages of patients receiving imaging or treatment modalities and percentages of clinicians reporting to use modalities in a range of clinical scenarios were analyzed. Statistical comparisons were performed.

Results: In total, 69 responses were received (Sweden [n = 20], United Kingdom [n = 16], Northern/Western Europe [n = 17], Southern Europe [n = 9], and Central Europe [n = 7]). Considerable variations between geographical areas were seen in terms of reported diagnostic modalities and treatment strategies. For example, when presented with the scenario of a theoretical 45-year-old smoking female with a suspected ACS, 56% of UK clinicians reported to use coronary computed tomography angiography, compared to only 10% of Swedish clinicians (P = .002). Large variations were observed regarding the reported use of fractional flow reserve by physicians for non-culprit lesions during invasive management of myocardial infarction patients (44% in Sweden, 31% in the United Kingdom, and 30% in Northern/Western Europe vs non-use in Central and Southern Europe).

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Conclusions: In this survey, respondents reported different diagnostic and treatment strategies in ACS care. These variations seem to have geographic components. Larger studies or real world data are needed to verify these observations and investigate their causes. More research is needed to compare the quality and efficiency of ACS care across countries and explore pathways for improvement.

KEYWORDS

ACS, clinical practice variation, Europe, imaging, revascularization treatment

1 | INTRODUCTION

Acute coronary syndrome (ACS) refers to conditions where the blood supplied to the heart muscle gets suddenly blocked leading to the death of cells in the heart tissues. In patients with suspected ACS, several imaging or functional testing modalities may be used to establish the diagnosis and to identify patients who should undergo myocardial revascularization. As different imaging and treatment options are currently available in the field, this variety might leave room for clinical practice variation at the European level.

Evidence suggests differences in ACS care and outcomes within Europe.[1] However, variations in clinical practice and outcomes in ACS care have mainly been analyzed at a national level, providing information about the relative patterns and performance of different hospitals within individual countries.[2] Although this information is crucial to assess the performance of hospitals and identify inequalities in care at the national level, between-country comparisons have received little attention and would provide a complementary opportunity for learning from foreign health care systems and improving national performances.[2] Furthermore, given the lack of reliable data, establishing the status of the use of cardiovascular imaging in Europe has been a priority for influential European associations in the field.[3]

While both surveys and registries are needed to verify whether clinical practice is in line with guidelines,[4] surveys offer the advantage to present specific clinical cases and obtain detailed information about diagnostic and management strategies.

In this context, we developed and used a web-based clinician survey to examine the diagnostic and treatment strategies reported by respondents and to identify potential variations in responses between countries or geographical areas within Europe. The focus was made on diagnostic tests (including coronary imaging and functional assessment) and revascularization treatment, in a range of clinical scenarios encompassing patients with known or suspected ACS.

2 | METHODS

2.1 | Study design

In order to assess clinical practice in ACS in Europe, we conducted an online clinician survey. The survey questions were formulated based on expert opinion and feedback collected from a European expert panel, which included five cardiologists and three radiologists.

A pilot phase was conducted before the survey was launched in March 2017. The survey was conducted using the online software "Google form" and was made available online. The target population for dissemination included non-invasive and interventional cardiologists, radiologists, and emergency physicians (including those completing their specialization).

No financial incentive was offered to participants and survey completion was voluntary. An ethics committee (EMC Rotterdam) reviewed the protocol and survey questions and concluded that this work was not subject to the Dutch law of medical research (WMO).

2.2 | Structure

A closed and structured format in English was chosen to enable clinicians to select their responses among multiple predefined choices. First, an introduction provided the framework of the study and was followed by general questions regarding the respondents' work setting. Subsequently, respondents were asked about the diagnostic workup and the proportions of high-risk and low- to intermediate-risk patients suspected with ACS who would receive different imaging modalities in the respondent's practice setting. Section 5 contained questions about the treatments used for ST-elevation myocardial infarction (STEMI) and non-ST segment elevation myocardial infarction (NSTEMI) patients while Section 6 focused on follow-up imaging. Questions related to specific patient cases and clinical scenarios were disseminated throughout the survey and are summarized in Table 1. The survey questions can be found in Supporting Information. A pilot-test phase was conducted after which the number of questions was reduced.

2.3 | Dissemination

The online survey link was circulated through email distribution lists and websites of national and European professional societies. The Swedish Society of Cardiology, the British Society of Cardiovascular Imaging, and the Radcliffe Cardiology group invited their members to participate in the survey through personal emails. The survey was

TABLE 1   Clinical scenarios as defined in the survey

Patient case number	Patient case	Procedure surveyed
1	45-year-old female woman suspected with ACS, admitted in the emergency department. She had no cardiovascular risk factor except for smoking during 20 y. She presents with an atypical chest pain, her ECG is normal and her troponin result is low.	Further examination
2	65-year-old NSTEMI patient who received PCI of the culprit lesion and presents a relatively good clinical status	Strategy for dealing with suspected non-culprit lesions
3	Patient over 50 years old, admitted to the health centre with chest pain and an ACS has been ruled out	Usual diagnostic strategy after an ACS was ruled out

Abbreviations: ACS, acute coronary syndrome; ECG, electrocardiogram; NSTEMI, non-ST segment elevation myocardial infarction; PCI, percutaneous coronary intervention.

circulated via the website of the Bulgarian Society of Cardiology, the Czech Nuclear Medicine Society, the European Society of Cardiovascular Radiology, and the Hungarian Society of Cardiology, which complemented this action with an announcement in their newsletter.

2.4 | Statistical analysis

Reported percentages of patients receiving imaging or treatment modalities and percentages of respondents reporting to use different invasive or non-invasive diagnostic tests or treatments were extracted from the clinicians' responses. Non-invasive diagnostic tests comprise anatomical imaging such as coronary computed tomography angiography (CTA) or functional (or stress) tests, including exercise electrocardiogram (ECG), stress echocardiography, and scintigraphic or magnetic resonance (MR) perfusion imaging. In ACS care, functional imaging is used to assess the haemodynamic characteristics of the heart. Invasive assessments require insertion of cardiac catheters and include invasive coronary angiography and fractional flow reserve (FFR) assessment during an interventional procedure.

Mean percentages were calculated for two countries (Sweden and the United Kingdom) and three clusters of countries (Central Europe, Northern/Western Europe, and Southern Europe) that were created based on the geographic location of the respondents and expected commonalities in their health care system. Given the breakdown of participants per country, Sweden and the United Kingdom were extracted from the Northern/Western Europe cluster and isolated for more detailed analyses. Our statistical analyses rely on the assumption that respondents can be considered to be independent observations. Based on background information of the hospital (city, academic centre, and number of MI diagnosed), the maximum possible number of respondents coming from the same centre is very low, which means that the potential influence of this possibility on the results is low.

The 95% confidence intervals (CIs) surrounding the mean estimates were computed using bootstrapping.[5] This involved randomly resampling the original samples with replacement 500 times, which corresponded to the number of replications needed to ensure stability and accuracy. Each bootstrapped sample yielded a bootstrap statistic (eg, mean frequency). The bootstrap distribution was computed from the 500 bootstrap statistics, per geographic area. Between-country and between-cluster comparisons of imaging and treatments were conducted using one-way ANOVA tests in SPSS (version 23). Statistical significance of the results was tested using a .05 level.

2.5 | General background regarding the availability and use of imaging modalities in the European Union

Previous studies reported considerable variation in the availability and use of imaging equipment in the European Union (EU). In 2015, Luxembourg recorded the highest number of angiography units per capita, followed by Italy and Sweden (Table 2).[6] Germany and Italy reported more than 2.8 magnetic resonance imaging (MRI) units per 100 000 inhabitants, in contrast to 0.4 MRI units per 100 000 inhabitants in Hungary. In 2016, Luxembourg and France had the highest number of CT scans per capita in the EU (21 100 scans and 20 400 scans per 100 000 inhabitants). Furthermore, while Sweden, and Northern Europe in general, are known for their early adoption of medical technologies, Eastern European countries tend to be late adopters.[7,8]

3 | RESULTS

We received responses from 74 clinicians. Of those, four non-European clinicians and one non-interpretable response set were excluded from the analysis. Among the 69 remaining respondents, 20 were from Sweden, 16 from the United Kingdom, 7 from Central Europe, 17 from Northern/Western Europe, and 9 from Southern Europe. Given that the survey was distributed by national professional societies, it was not possible to calculate the response rate. We acknowledge the fact that the response rate might be small. Details about the respondents' characteristics and work environment can be found in Table 3.

3.1 | Initial diagnostic workup

On the basis of all answers, ECG combined with biochemical tests was reported as the mainstay of the first-line diagnostic workup for both

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TABLE 2 Availability and use of imaging equipment in a set of selected EU countries (6)

Per 100 000 inhabitants	Availability			Use	
	Angiography units (2015)	CT scanners (2016)	MRI units (2016)	CT scanners (2016)	MRI units (2016)
France	0.7	1.7	1.4	20 439	11 385
Germany	1.1	3.5	3.5	14 310[a]	13 616[a]
Hungary	0.6	0.9	0.4	11 619	4224
Italy	1.4	1.3[a]	2.8[a]	8129	6710
Luxembourg	1.6	1.7	1.2	21 064	8340
Spain	0.6	1.8	1.6	10 870	8245
Sweden	1.3	2.2	1.6	NA	NA
United Kingdom	NA	1	0.7	8470	5676

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging.
[a]2015.

TABLE 3 Respondents' characteristics

	Number	%
Number of respondents	69	100
Countries and clusters		
Sweden	20	29%
United Kingdom	16	23%
Central Europe (Czech Republic, Hungary, Romania, Serbia)	7	10%
Northern and Western Europe (Finland, France, Germany, Ireland, Luxembourg, Netherlands)	17	25%
Southern Europe (Greece, Italy, Spain, Macedonia)	9	13%
Specialty		
Cardiologist	42	61%
Cardiologist and emergency physician	1	1%
Cardiologist and PCI operator	17	25%
Cardiologist, PCI operator and emergency physician	1	1%
Emergency physician	1	1%
PCI operator	2	3%
Radiologist	5	7%
Financing system		
Public	64	93%
Private	5	7%
Teaching category		
Academic hospital	48	70%
Non-academic hospital	21	30%

Abbreviation: PCI, percutaneous coronary intervention.

high-risk patients (79%; 95% CI: 70%, 87%) and low- to intermediate-risk patients (68%; 95% CI: 58%, 78%) admitted to a health centre in Europe with chest pain and suspected ACS. Across the different investigated areas, non-invasive test appears to respondents to play a greater role to establish or rule out the diagnosis of an ACS in low- to intermediate-risk patients than in high-risk patients. Indeed, while an average of 64% of the low- to intermediate-risk patients were reported to receive non-invasive imaging (with ECG plus biochemical tests, with ECG only and with biochemical tests only), only 48% of the high-risk patients were reported to receive it (see Figure S1).

3.2 | Diagnosis of a low risk patient

The first patient case described a 45-year-old woman suspected with ACS admitted in the emergency department with no cardiovascular risk factors except for smoking for 20 years, atypical chest pain, a normal ECG, and a low troponin result. The respondents were asked to indicate what further investigations they would perform. In this hypothetical clinical case, the vast majority of the clinicians responded they would opt for a combination of coronary CTA and/or echocardiogram and/or stress tests (see Figure 1). The combination of tests reported by the respondents can be found in Figure S2. On the basis of the responses, stress tests (including treadmill, scintigram, stress echocardiogram, or stress MRI) would be obtained by 43% to 65% of the respondents in each of the five investigated areas. The use of coronary CTA was reported to be the highest among UK respondents (56%) and lowest among Swedish respondents (10%) (P = .002). Swedish and Southern Europe respondents strongly favoured stress tests in this context.

Significantly more UK respondents (56%) than Swedish respondents (10%) reported they would use coronary CTA (P = .002). Large variations were also observed regarding the use of echocardiogram: while 71% of the respondents from Central Europe reported they would perform an echocardiogram, this was only 22% in Southern Europe and 25% in the United Kingdom. Interestingly, throughout the different geographic areas, a varying proportion of respondents (0%-22%) reported they would not perform any further examination.

3.3 | Imaging modality guiding treatment decision for patients with a high probability of ACS after biochemical tests

Overall, European respondents reported that an average of 60% of their patients presenting with a high probability of ACS after biochemical tests receive echocardiogram (see Figure S3). Furthermore, European respondents reported that an estimated 54% of their patients receive invasive coronary angiography without FFR compared to 37% receiving invasive coronary angiography with FFR.
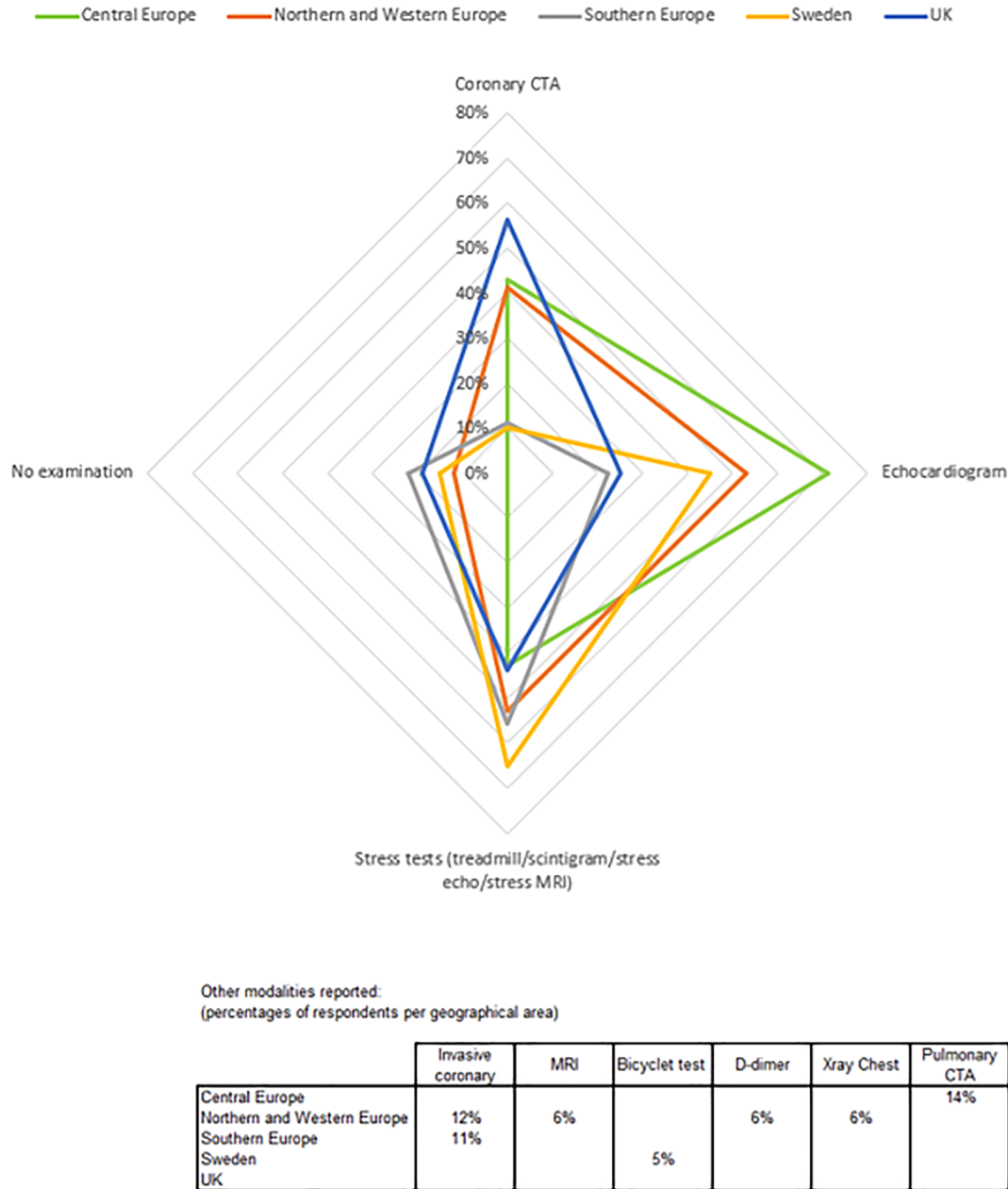
FIGURE 1 Percentages of clinicians reporting to use different examinations in the diagnosis of a low risk patient (patient case 1)

Southern European respondents reported the lowest frequencies of FFR combined with invasive coronary angiography. While UK respondents reported using coronary CTA for an average of 14% of their patients, Swedish respondents reported using it for only 3% (P = .04).

3.4 | Diagnosis after ruling out ACS

Figure 2 shows the frequencies of diagnostic tests for patients over 50 years of age admitted with chest pain and after an ACS was ruled out, based on the proportion of patients per test reported by each respondent (patient case 3). For these typical patients, UK respondents reported using bicycle ECG less often

than the other European respondents. The difference between British and Swedish respondents was statistically significant (4.5% vs 57%; P = .00). Interestingly, UK respondents appear to be almost equally divided between performing stress echocardiogram, coronary CT scan, and invasive coronary angiography, with frequency rates close to 20% for each test. UK respondents, together with Northern/Western Europe respondents, reported the highest frequencies of stress MRI: 15% and 15.5%, respectively. On average, English respondents estimated that 15% of their patients matching the hypothetical case 3 description receive stress MRI, which means that this imaging modality is significantly more often reported in the United Kingdom than in Sweden, Central Europe, and Southern Europe (P < .05), in the described context. The reported use of stress MRI also appears
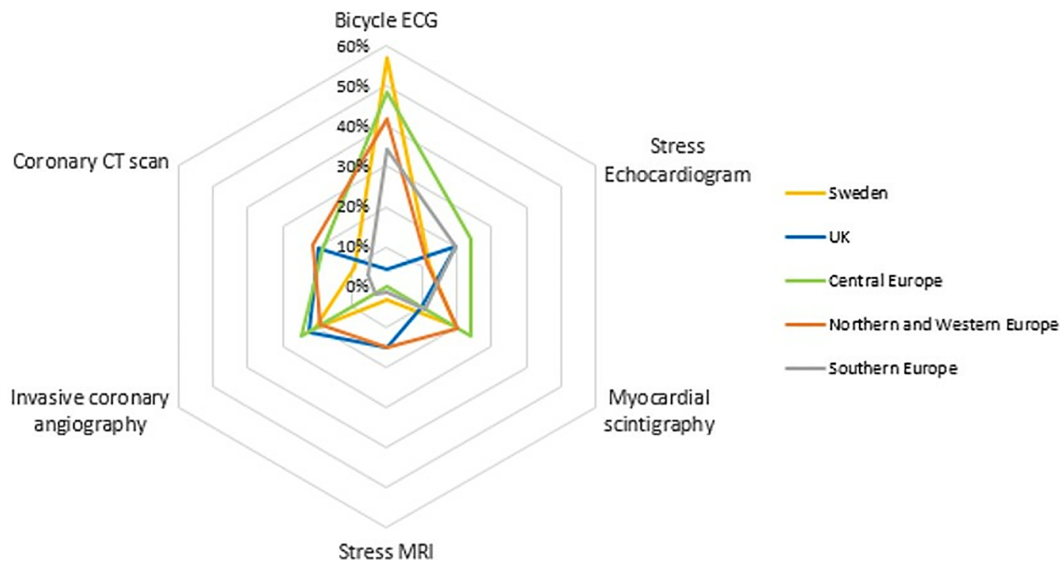
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FIGURE 2 Reported percentages of patients receiving different diagnostic strategies after an ACS was ruled out (patient case 3). ACS, acute coronary syndrome

to be significantly greater in London than in other UK cities (P < .01).

3.5 | Average time between diagnosing a NSTEMI patient and performing invasive coronary angiography

The reported time between diagnosing an NSTEMI patient and performing invasive coronary angiography appear to vary substantially between and within the investigated areas. While 18% of the whole group of respondents (12/69) estimated an average time of 24 hours between diagnosis and invasive coronary angiography, 52% (36/69) of these respondents reported a delay of more than 24 hours. Of these 36 respondents, 13 estimated a delay of at least 72 hours, hence a total of 19% (13/69) of the whole group. Interestingly, while 45% (9/20) of the Swedish respondents reported performing coronary angiography within 24 hours, all UK respondents estimated this delay to be greater than 24 hours.

3.6 | Reperfusion treatment method for patients presenting with a STEMI and revascularization treatment method for patients presenting with a primary NSTEMI

Figure 3 shows the reported frequencies of reperfusion treatments and revascularization treatments given to STEMI patients (A) and NSTEMI patients (B), respectively, who were not contra-indicated for any treatment. Percutaneous coronary intervention (PCI) was reported as the primary treatment modality for both STEMI and NSTEMI patients. This was the case in all geographical areas, although the actual percentage varied somewhat between geographical areas, with ranges of 77% to 96% for STEMI patients and

67% to 91% for NSTEMI patients. For the two categories of patients, the lowest rates of PCI were reported in the United Kingdom. The UK respondents also reported the highest rate of intravenous thrombolysis, with nearly 14% of their STEMI patients receiving it, compared to an average of 2% to 6% reported in the other geographic areas. Regarding the NSTEMI group, UK respondents reported the highest rate of coronary artery bypass grafting (CABG) (19%) across the investigated areas.

3.7 | Treatment of non-culprit lesions

In a second patient case, respondents were asked about how they would treat suspected non-culprit lesions in a 65-year-old NSTEMI patient presenting with a relatively good clinical status following the PCI of the culprit lesion. For this typical patient, slightly more than one-quarter of the whole group of European respondents (19/69 = 28%) reported they would opt for conservative management with PCI only in the case of symptoms or reversible ischemia on stress tests (see Figure 4). Despite this trend, large variations are observed between responses across geographical areas: while this strategy was chosen by 56% and 57% of the respondents in Southern Europe and Central Europe, respectively, it was selected by only 16% to 25% of the respondents in the United Kingdom, Sweden, and Northern/Western Europe. The strategy of FFR was chosen by 26% (18/69) of the total group: 16% (11/69) of the whole European respondents opted for an immediate FFR-guided PCI during index catheterization, 9% (6/69) for a staged FFR-guided PCI during index hospitalization, and one respondent opted for a staged FFR-guided PCI between 4 and 8 weeks. Among the respondents reporting PCI, the strategy of immediate PCI was most prevalent in the United Kingdom and Sweden (67% and 36%, respectively) (Figure 4B). No clinician from Southern Europe reported FFR-guided PCI or immediate PCI in case of non-culprit lesions (Figure 4B).

FIGURE 3 A, Reported percentages of STEMI patients receiving different reperfusion treatments. B, Reported percentages of NSTEMI patients receiving different revascularization treatments. NSTEMI, non-ST segment elevation myocardial infarction; STEMI, ST-elevation myocardial infarction
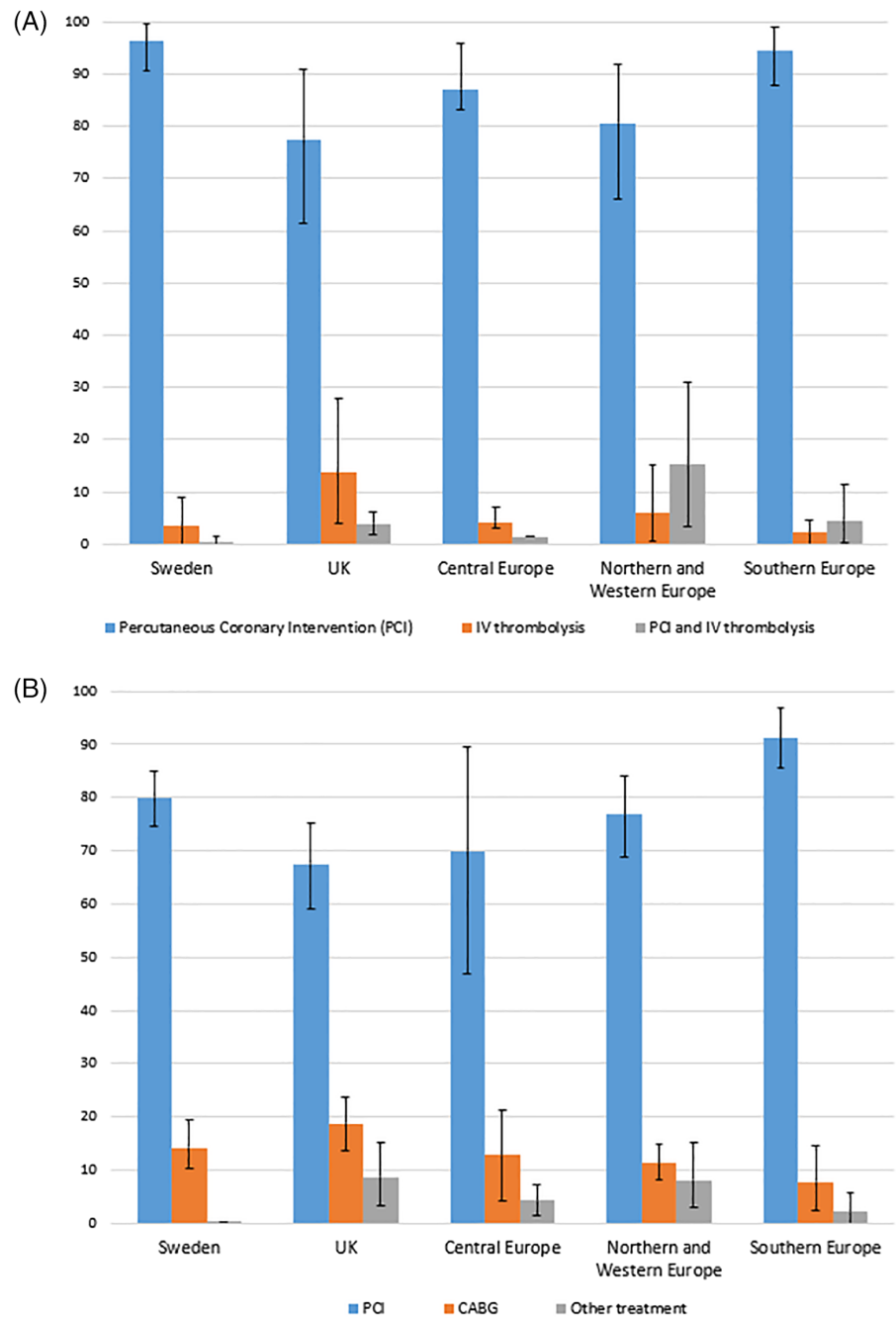
Totals per country do not sum up to 100% due to respondents who reported a "I do not know" answer.
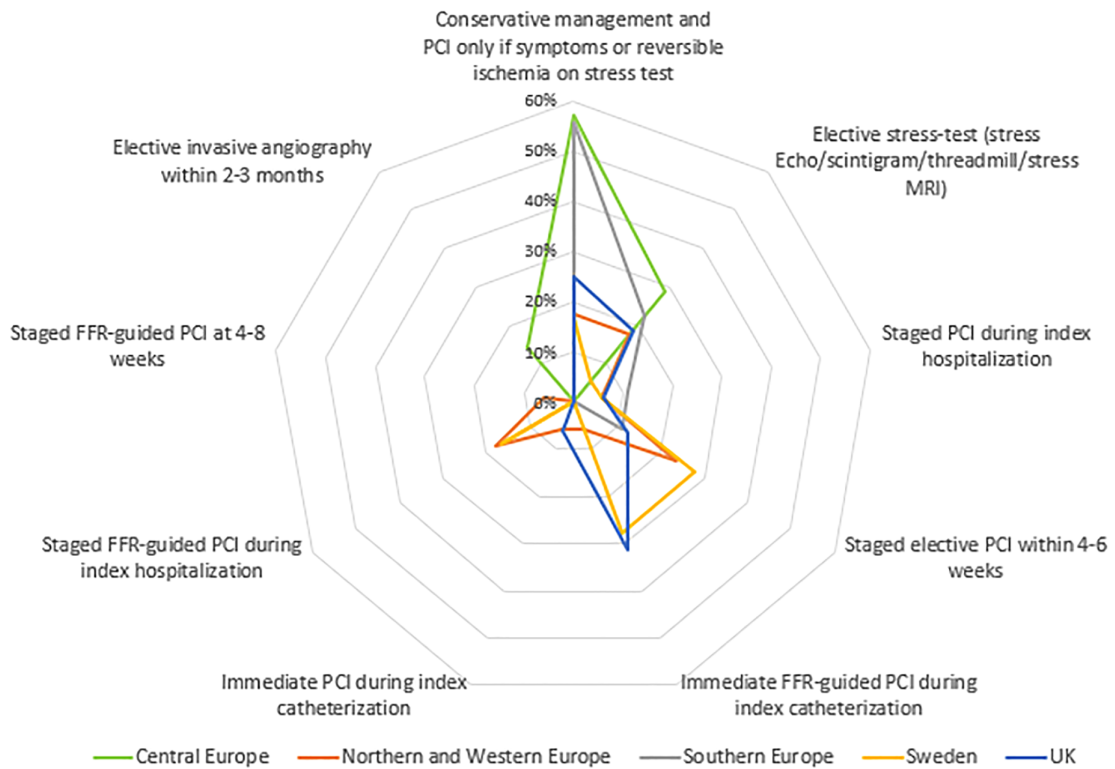
4 | DISCUSSION

To the best of our knowledge, this study presents the first online survey aimed at describing and analyzing reported diagnostic and treatment practices in ACS care across European regions and countries. This study also provides detailed data related to a range of clinical scenarios that focus on strategies for specific patients.

Considerable variations in the respondents' answers were observed in both the diagnostic and treatment phases of patients with known or suspected ACS. In addition, comparative analyses revealed significant differences between the responses from Swedish and UK clinicians.

4.1 | Availability and reimbursement of diagnostic tests

The survey results showed that significantly lower frequencies of CTA use were reported by the Swedish respondents compared to the UK

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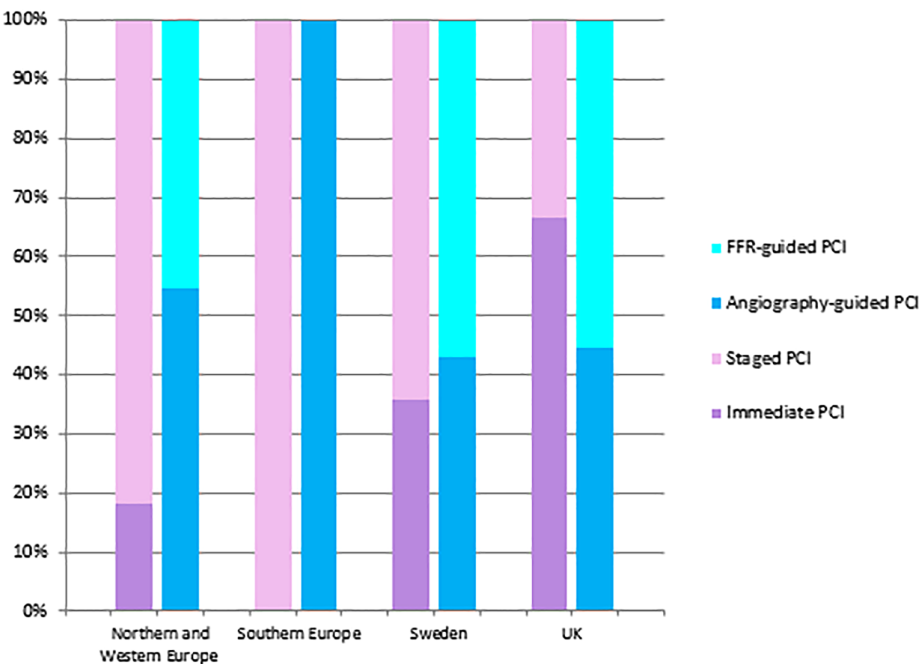
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(A)

(B)

FIGURE 4 A, Percentages of clinicians reporting their most common strategy in treating non-culprit lesions (patient case 2). B, Percentages of clinicians reporting different approaches when performing PCI of the non-culprit lesion (patient case 2). PCI, percutaneous coronary intervention

respondents. This may be explained by the facts that CTA is increasingly but not widely available in Sweden[9] and that CTA was incorporated into the UK NICE guidelines for patients at low risk of CAD.[10] By means of the specific patient cases presented in the survey, MRI was significantly more often reported by UK respondents than by Swedish respondents. Furthermore, respondents from London

reported MRI to be more frequently used than respondents from other UK cities. These studies showed a rapid increase in use of cardiac MRI in patients with ACS and striking variations in use between high volume centres, in and around London, and the rest of the country.[11] A major factor that might explain the wide availability and the increased use of MRI scanners in the United Kingdom is the fact that
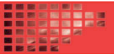
cardiac MRI is funded for assessment of ischaemic heart disease (including suspected ACS) and other heart diseases. The situation is different in many other European countries where different reimbursement schemes are in place and issues regarding reimbursement may need to be solved.[12] Further research would be needed to assess whether the geographical imbalance observed in the responses within and between countries reflects an overuse in the United Kingdom, and especially in London, or underuse patterns outside of London and in other European countries. As cardiac MRI is an accepted modality for assessment of suspected coronary disease, the question of potential overuse mainly relates to the cost-effectiveness of the test.

Although the value of FFR to evaluate intermediate lesions or guide selection of lesions for revascularization in patients with multivessel disease is widely accepted,[13] modest rates were reported in this survey. This observation might reflect a low use or even a low implementation of FFR in Europe. It might also relate to the fact that the prognostic role of FFR in guiding myocardial revascularization in patients with an ACS needs additional clarification.[14,15] Although FFR-guided PCI has been proven to reduce mortality and MI compared to angiography-guided PCI in patients with stable angina,[16] considerable differences were observed in the survey responses between regions and countries. In that case again, reimbursement remains a major constraint preventing FFR from being widely utilized in Europe: differences remain between countries that have allowed their hospitals to cover the costs of FFR procedures (like the United Kingdom and Germany) and other European countries where this is not reimbursed.[17]

4.2 | Guidelines

Our findings showed that the reported time between diagnosing an NSTEMI patient and performing invasive coronary angiography varied substantially between and within the geographical areas of the respondents.

Although the European Society of Cardiology (ESC) guidelines recommend revascularization within 24 hours in high-risk patients and within 2 hours in very high-risk patients,[15] this can be a challenge in contemporary cardiac care in Europe. Achieving revascularization within 24 hours was reported as a major challenge for Sweden in the SWEDEHEART Annual report of 2017.[9] National Institute for Health and Care Excellence (NICE) guidelines recommend coronary angiography within 72 hours for intermediate or higher risk patients.[18] We think that the influence of NICE guidelines in the United Kingdom might partly explain why the times reported by UK respondents show a shift towards later intervention compared to the times reported by the Swedish respondents.

4.3 | Treatments

The relatively high reported rates of PCI for reperfusion in STEMI patients and for revascularization in NSTEMI patients might reflect a widespread access to PCI throughout Europe. Despite this trend, lower rates of PCI were reported by UK respondents and variations in the answers were seen between all geographical areas; these two observations are consistent with previous studies.[19] European respondents reported PCI as the most common invasive treatment for STEMI and NSTEMI patients, although the efficacy and durability of CABG over PCI (for different groups of patients) was largely demonstrated.[20,21] CABG remains highly recommended in patients characterized by multivessel disease, diabetes, or lesion complexity. In Sweden, the volume of CABG procedures has been declining over the past 35 years but considerable differences in the proportion of CABG and PCI out of the total of revascularization exist across hospitals.[9] This large variability might indicate that some patients do not receive the optimal treatment and highlight that further studies would be needed to investigate the optimal rates of CABG and PCI. Comprehensive research is needed on barriers to implementation, and more generally, on factors and structure that determine the diffusion, implementation, and variations in use of PCI within and between European countries.

Finally, we analyzed clinicians' responses regarding whether and when non-culprit lesions are treated and intended to identify possible geographic trends. While guidelines recommend a staged approach in the treatment of patients with STEMI and multi-vessel disease,[13] there is no evidence supporting the superiority of a staged over an immediate approach and no evidence regarding the best approach for NSTEMI patients.[22]

By means of a survey, this study investigated clinical situations where evidence might remain uncertain or lacking. Indeed, the survey guaranteed that respondents answer to the exact same case, which allows preliminary international comparisons in clinical areas where registry data might not exist, capture limited details, be poor in quality, or not be available to third parties.

5 | LIMITATIONS

As a main limitation of our study, we acknowledge that a limited number of responses was received, implying a risk of selection bias and constraining generalizability of our results. Further research would be needed to ascertain and generalize our findings. However, our results are consistent with previous studies in the field and identify considerable differences in the reported strategies between areas.

6 | CONCLUSIONS

Our study revealed considerable variation in the reported modalities of diagnostic and treatment strategies in patients with suspected or established ACS across Europe. We have discussed potential causes for the reported differences in the utilization of these techniques that range from evidence regarding availability of techniques, guidelines, and reimbursement. Such differences may indicate that some patients do not receive the best available care and may have an important impact on the quality of health care and patient outcomes across geographical areas.

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Complementary research might be possible to gather generalizable data and confirm these variations, investigate their causes and assess how much they reflect health care inefficiency and result in inequalities in patient outcomes. This could be done by either exploiting existing high quality registries or setting them up with a specific scope in terms of patient population. The latter might require considerable resources though.

Further research investigating the country-specific cost-effectiveness of diagnostic and treatment strategies in ACS care might be needed to define the most cost-effective way for diagnosing and treating patients per country. Such studies would inform national policy makers and help them decide what cardiovascular technologies to promote and reimburse in order to maximize health gains and/or minimize costs, in the context of their local specificities and constraints. While large European studies such as the SPCCT (Spectral Photon Counting CT) project aim at developing new technologies,[23] stronger evidence regarding current local care, by means of surveys or alternative methods, might be needed before the role and value of new imaging modalities in the clinical arena can be assessed.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.