Physicians' perceptions on the impact of COVID-19 in coronary artery disease diagnostic imaging and treatment: A Latin America survey. For the Society of Cardiovascular Imaging of the Inter-American Society of Cardiology

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ABSTRACT

Background: Services during the pandemic were severely restricted, public reluctance to seek medical assistance rose, with a reduction of diagnostic and therapeutic modalities use in coronary artery disease (CAD). However, information about perceived barriers of care among cardiologists is limited. We aim to explore these barriers diagnostic and treatment modalities of CAD in Latin America during the pandemic.
Methods: An anonymous Google form 12 closed-questions survey was conducted between November 2020 to January 2021. Latin American cardiologists members of the Imaging Society (SISIAC) of the Inter-American Society of Cardiology (SIAC) were reached by email and social media.
Results: Differences were found in relation to patients' perceived reluctance to undergo testing, particularly in South America and inpatient care ($p < 0.05$). Respondents' perceived barriers in the use of CV tests were higher in South America ($p < 0.05$) and related to public practice ($p < 0.01$). Barriers to the treatment of myocardial infarction were present in all regions ($p < 0.05$), and follow-up was influenced by COVID-19 in both public and private practices ($p = 0.01$).
Conclusions: Regardless of treatment and diagnostic approach (invasive or non-invasive) followed, according to physicians' perception, the pandemic significantly impacted the clinical management of CAD in the Latin American population, similar to the global situation.

1. Introduction

As a result of SARS-CoV-2′s highly contagious nature, social distancing, confinement, and curfew measures were implemented worldwide, leading to significant public anxiety. The saturation and near collapse of health care systems caused by the pandemic has

hampered medical care in every field, including cardiovascular (CV) medicine. Furthermore, limitations in transportation and collective fear have had a significant negative impact on the quality of care and outcomes of CV diseases, given the adverse prognosis of COVID-19 among those with pre-existing cardiac conditions and risk factors [1,2,3].

The pandemic has also altered clinicians' ability to diagnose and follow patients with coronary artery disease (CAD) even not affected by SARS-CoV-2. Recent data has shown 55%-78% reductions in the use of testing modalities. Similarly, diagnostic catheterization and interventional services use has dropped across many areas of the globe [4,9,10].

The increase of out-of-hospital cardiac arrests and CV deaths during the pandemic and gaps between expected and observed fatalities imply that non-COVID-19 etiologies and disruption of care may lead to worse outcomes [5,7,8]. Areas with limited resources have witnessed disproportionate harmful consequences, as seen in some Brazilian cities with high rates of COVID-19 mortality where the observed reduction in deaths associated with Acute Coronary Syndrome (ACS) and stroke paralleled increased frequency unspecified CV and home deaths due to missed diagnoses [6].

Since the clinical approach to suspected CAD typically relies on non-invasive methods, analyzing their use during the pandemic may constitute a valuable undertaking, as it could derive from implementing cost-effective protocols.

We aimed to explore the perceived barriers and usage patterns of cardiac testing and treatment modalities in acute or chronic CAD in Latin America during the earlier stages of the COVID-19 pandemic before and soon after, the implementation of protocols and guidelines supported by international professional societies.

2. Methods

An anonymous Google form 12-closed-questions survey was sent to Latin American members of the Imaging Society (SISIAC) of the Inter-American Society of Cardiology (SIAC). The authors developed the questionnaire and validated it through the face validity method; a non-probability sampling design was used. Representatives of each country member of SISIAC were assigned the task of contacting local cardiologists via email or social media; a total of 1200 questionnaires were distributed electronically. The survey was originally delivered in Spanish, and a cross-validated translation was used for this manuscript. The information was recruited between November 2020 and January 2021. For analytical purposes, countries were divided by regions: South America (Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Paraguay, Peru, Uruguay, and Venezuela); Mexico, and Central America and the Caribbean (Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, Panama, and Puerto Rico).

The questions addressed practitioners' characteristics, including gender, specialty, type of practice (outpatient or inpatient), and type of institution (public and private); their perceptions concerning patients' attitudes towards diagnostic testing, barriers in the performance of diagnostic studies and practice patterns towards CAD, including treatment and follow-up, in the context of the COVID-19 pandemic. Cardiovascular imaging techniques available in Latin America vary considerably among nations; therefore, the questionnaire was written to apply in every scenario. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee.

2.1. Statistical analysis

Univariate analysis was used to describe the frequency of distribution and percentages of the different perceptions included in the survey. In addition, multivariate logistic regression models were used to assess associations between patients' baseline characteristics (region, gender, specialty, type of practice, and type of institution) and population responses. An independent regression model was utilized for every

question using factor variables to adjust for ordinal variables. A p-value < 0.05 was considered significant, and it was adjusted for multiple comparisons. Statistical analyses were performed using Stata software, version 17 (StataCorp) or SAS software, version 9.2 (SAS Institute).

3. Results

A total of 1200 questionnaires were distributed during a three-month period (November 2020-January 2021). The percentages are expressed in whole numbers. A total of 777 (64%) physicians submitted their individual responses; 603 (78%) were from South America: Argentina 222 (29%), Brazil 42 (5%), Colombia 79 (10%), Chile 18 (2%), Ecuador 30 (4%), Peru 39 (5%), Uruguay 37 (5%), Paraguay 51 (7%), Venezuela 72 (9%) and Bolivia 13 (2%) followed by those from Central America and the Caribbean: 128 (16%) Panama 30 (4%), Dominican Republic 39 (5%), Honduras 2 (0.2%), Costa Rica 11 (1%), Nicaragua 6 (1%), Puerto Rico 1 (0.12%), El Salvador 19 (2%), Guatemala 6 (1%), Cuba 14 (2%) and Mexico 46 (6%).

Most responders 475 (61%) were male; 319 (41%) specialized in clinical cardiology/echocardiography. In relation to the type of institutions where they practiced, 42% work at public governmental facilities; 16% at private ones; and 42% at both public and private. As to the type of practice, most participants cared for both outpatients and inpatients (64%) (Table 1, Supplementary material).

The most common answer in every survey question from the 5-point scale was 'agree', meaning most physicians agreed to identify some barriers in CAD diagnosis and treatment due to COVID-19 pandemic (Fig. 1). Up to 25% of respondents disagree with the perception of barriers in the different proposed scenarios.

Statistical differences were found through multivariate logistic regression analysis (R2 = 0.05; F = 3.23; p < 0.0001) in relation to perceived patients' reluctance to undergo diagnostic testing for suspected CAD. This perceived reluctance being particularly higher in South America (0.29, 95% CI: 0.09–0.49; p < 0.05), which would indicate a higher likelihood of perceived reluctance in this region compared to the others. A further significant relation was also encountered between reluctance and inpatient care (-0.32, 95% CI: −0.63–0.01; p = 0.05), meaning there is a reduced probability of perceived reluctance when physicians provide inpatient care (Table 2).

Perceived changes in diagnostic testing strategies were significantly related to public services (0.26, 95% CI: 0.01–0.5; p = 0.04), indicating a higher likelihood of perceived changes in diagnostic testing strategies compared to private practice. Respondents' perceived barriers in the use of echocardiography and stress modalities were also higher in South America (0.37, 95% CI: 0.15–0.58; p < 0.05) and significantly related to public practice (0.43, 95% CI: 0.19–0.67; p < 0.01), suggesting a higher probability of physicians' perception of barriers in performance of echocardiography and stress modalities compared to other regions or private practice.

Barriers in the use of CT or CMR were encountered in public practice (0.72, 95% CI: 0.47–0.97; p = 0.01), indicating a higher likelihood in this scenario in the perception of barriers towards the use of CT or CMR compared to private practice. No regional relationship was found in this case, perhaps related to the lower availability of those diagnostic methods due to redistribution of resources at the beginning of the health emergency. Regarding barriers in the invasive diagnosis of CAD, we found a significantly reduced probability in Mexico (-0.38, 95% CI: −0.76–0; p = 0.05) compared to the other regions. Mostly, these barriers were significantly more likely perceived by physicians who did not practice interventional cardiology (0.46, 95% CI: 0.07–0.84; p = 0.02). In all three regions, there was a reduced likelihood of perceived barriers in the treatment of AMI (-0.46, 95% CI: −0.88–0.04; p = 0.03). Follow-up was hampered by COVID-19 according to physicians' perception who worked in public practices (0.44, 95% CI: 0.19–0.69; p = 0.01), indicating a significantly higher probability in this setting compared to private practices. Notably, we found no differences related to the type of
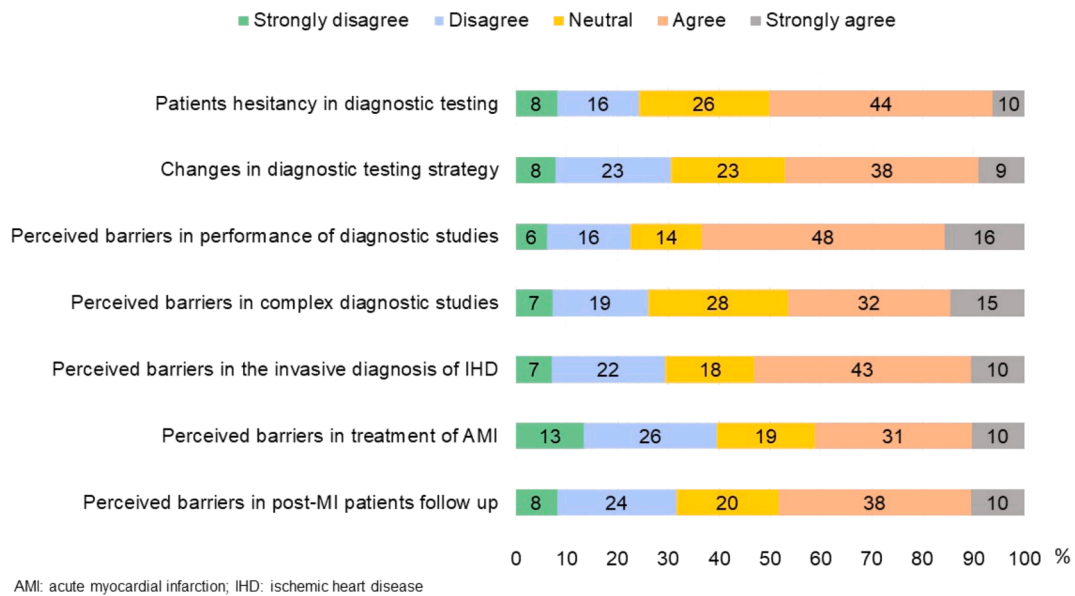
Fig. 1. Barriers perception in CAD imaging diagnosis and treatment among cardiologists due to COVID-19 pandemic.

Table 1
Respondents baseline characteristics by subgroups.

	Total (n = 777)	Central America and the Caribbean 128 (16%)	Mexico 46 (6%)	South America 603 (78%)
Gender (n,%)				
Male	475 (61)	80 (62)	25 (54)	370 (61)
Female	302 (39)	48 (38)	21 (46)	233 (39)
Specialty				
Clinical Cardiology	165 (21)	40 (31)	5 (11)	120 (20)
Clinical Cardiology / Echocardiography	319 (41)	45 (35)	19 (41)	255 (42)
Echocardiography	207 (27)	19 (15)	15 (33)	173 (29)
Nuclear Medicine	9 (1)	2 (2)	0	7 (1)
Interventional Cardiology	23 (3)	7 (5)	1 (2)	15 (2)
Intervention / Echo / Clinical Cardiology	11 (1)	7 (5)	1 (2)	3 (1)
Clinical Cardiology / Echo / CV Imaging	43 (6)	8 (7)	5 (11)	30 (5)
Type of practice				
Outpatient	220 (28)	36 (28)	16 (35)	168 (28)
Inpatient	59 (8)	8 (7)	2 (4)	49 (8)
Both	498 (64)	84 (65)	28 (61)	386 (64)
Institution				
Public	329 (42)	22 (17)	8 (17)	94 (15)
Private	124 (16)	42 (33)	17 (37)	270 (45)
Both	324 (42)	64 (50)	21 (46)	239 (40)

institution.

4. Discussion

This survey gathered important information on current perceptions barriers among cardiologists dealing with suspected or manifest acute or chronic CAD. Respondents were predominantly male and practiced clinical and non-invasive cardiology in Latin American public and private institutions (Table 1). Results may or may not be equally applicable to all countries, given diverse practice patterns, resources availability, and infection prevalence.

There were regional differences in how non-invasive cardiac testing use was perceived, particularly echocardiography or stress testing. Most participants felt that patients' reluctance towards testing was significant, mainly in South America, which could be explained by the higher numbers of respondents from this region.

We found that most physicians surveyed perceived that indeed there were barriers in care related to the COVID-19 pandemic. However, up to 25% disagreed with this premise, probably due to physicians' intrinsic demographic/cultural differences and COVID-19 burden in each country. The potential barriers we predicted that might be present in every scenario are: limitations to exercise due to active pulmonary disease, COVID-19 respiratory sequelae or face mask impediment; medical and non-medical staff reluctance to treat or expose themselves to COVID-19 patients, lack of personal protection equipment, repeated sterilization of equipment after each use, decrease indication of diagnostic studies due to patients' absence in the ambulatory clinic.

Limitations in CAD and ST-Elevation Myocardial Infarction (STEMI) invasive diagnosis, treatment, and follow-up were also prevalent similar to the findings from Mayol et al. In this survey, the authors demonstrated an apparent decrease in the prevalence of STEMI and a delay in STEMI reperfusion in Latin America [11].

Multiple factors could explain these findings: variable access to telemedicine, which could facilitate earlier and more effective diagnostic evaluation; the dynamic epidemiological behavior of the pandemic at the time of the survey (although we found no significant

Table 2
Regression analysis of physicians' perceived barriers in CAD imaging diagnosis.

	Have you noticed patients' hesitancy in scheduling diagnostic testing during the pandemic?		Have you changed your diagnostic testing strategy when assessing patients with IHD?		Have you perceived barriers in the performance of diagnostic studies for IHD (echo or stress testing)?		Have you perceived barriers in the performance of complex diagnostic studies such as CT/CMR?		Have you perceived barriers in the invasive diagnosis of IHD?		Have you perceived barriers in the invasive/ percutaneous treatment of AMI?		Have you perceived barriers in the follow-up of post-MI patients?	
	Coeff (95% CI)	p value	Coeff (95% CI)	p value	Coeff (95% CI)	p value	Coeff (95% CI)	p value	Coeff (95% CI)	p value	Coeff (95% CI)	p value	Coeff (95% CI)	p value
Region														
Latin America/Caribbean	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Mexico	0.32 (-0.02–0.67)	0.06	0.13 (0.26–0.51)	0.51	0.23 (-0.15–0.61)	0.23	0.04 (-0.34–0.42)	0.84	−0.38 (-0.76–0)	0.05	−0.46 (-0.88–0.04)	0.03	−0.1 (-0.49–0.29)	0.61
South America	0.29 (0.09–0.49)	0.01	0.03 (-0.19–0.25)	0.82	0.37 (0.15–0.58)	0.01	0.07 (-0.15–0.29)	0.52	−0.21 (-0.43–0.01)	0.07	−0.27 (-0.51–0.03)	0.03	0.08 (-0.14–0.3)	0.48
Gender														
Male	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Female	0.07 (-0.08–0.22)	0.34	−0.01 (0.15–0.89)	0.89	−0.02 (-0.19–0.14)	0.78	−0.14 (-0.31–0.02)	0.09	0.01 (-0.15–0.18)	0.9	−0.17 (-0.35–0.01)	0.06	−0.01 (-0.18–0.16)	0.93
Specialty														
Clinical Cardiology	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Clinical Cardiology/Echo	0.08 (-0.11–0.27)	0.41	0.19 (-0.03–0.4)	0.09	0.15 (-0.06–0.37)	0.15	0.1 (-0.11–0.32)	0.34	0.07 (-0.14–0.29)	0.5	0.16 (-0.08–0.4)	0.18	0.03 (-0.19–0.25)	0.8
Echocardiography	0.06 (-0.15–0.27)	0.59	0.2 (-0.04–0.43)	0.1	0.03 (-0.21–0.26)	0.83	−0.02 (-0.25–0.22)	0.88	0.03 (-0.21–0.26)	0.83	0.1 (-0.16–0.35)	0.46	−0.15 (-0.39–0.09)	0.21
Nuclear Medicine	0.53 (-0.14–1.21)	0.12	0.41 (-0.34–1.17)	0.28	−0.16 (-0.9–0.59)	0.68	0.05 (-0.7–0.81)	0.89	0 (-0.76–0.76)	1	0.23 (-0.6–1.06)	0.59	0.77 (0–1.54)	0.05
Interventional Cardiology	0.23 (-0.22–0.67)	0.32	0.01 (-0.48–0.51)	0.95	−0.01 (-0.5–0.48)	0.98	0.05 (-0.45–0.54)	0.85	−0.11 (-0.61–0.39)	0.66	0.02 (-0.53–0.56)	0.95	−0.12 (-0.63–0.39)	0.64
Intervention/Echo/CC	0.43 (-0.2–1.05)	0.18	−0.26 (-0.95–0.44)	0.47	−0.67 (-1.36–0.02)	0.06	−0.36 (-1.06–0.33)	0.31	−0.61 (-1.3–0.09)	0.09	−0.28 (-1.04–0.49)	0.48	−0.78 (-1.49–0.07)	0.03
CC/Echo/CV Imaging	0.16 (-0.18–0.5)	0.35	0.19 (-0.19–0.58)	0.32	0.38 (0.01–0.76)	0.05	−0.25 (-0.63–0.14)	0.21	0.46 (0.07–0.84)	0.02	0.37 (-0.05–0.79)	0.08	0.21 (-0.18–0.6)	0.29
Institution practice														
Private	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Public	−0.07 (-0.29–0.15)	0.52	0.26 (0.01–0.5)	0.04	0.43 (0.19–0.67)	0.01	0.72 (0.47–0.97)	0.01	0.4 (0.15–0.65)	0.01	0.13 (-0.14–0.41)	0.33	0.44 (0.19–0.69)	0.01
Both	−0.11 (-0.27–0.06)	0.2	0.16 (-0.02–0.34)	0.07	0.14 (-0.04–0.32)	0.13	0.18 (0–0.36)	0.05	0.14 (-0.05–0.32)	0.14	0.14 (-0.06–0.34)	0.17	0.25 (0.07–0.43)	0.01
Type of practice														
Outpatients	1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Inpatients	−0.32 (-0.63–0.01)	0.05	−0.08 (-0.43–0.26)	0.64	0.16 (-0.18–0.51)	0.34	−0.16 (-0.5–0.19)	0.38	−0.06 (-0.41–0.28)	0.72	0.01 (-0.37–0.39)	0.95	0.3 (-0.05–0.65)	0.09
Both	−0.08 (-0.25–0.09)	0.37	−0.02 (-0.21–0.17)	0.84	0.06 (-0.12–0.25)	0.51	−0.17 (-0.36–0.02)	0.08	0.02 (-0.17–0.21)	0.83	0.02 (-0.19–0.23)	0.84	−0.1 (-0.29–0.09)	0.31

AMI: acute myocardial infarction, CC: clinical cardiology, CI: confidence interval, CMR: cardiac magnetic resonance, CV: cardiovascular imaging, CT: compute tomography, IHD: Ischemic heart disease.

difference in positivity nor mortality rates within the analyzed countries); and lower availability of diagnostic methods in low-income regions due to the redistribution of resources at the beginning of the pandemic. In line with these, Einstein *et al.* reported the global impact of COVID-19 on both non-invasive and invasive testing of CAD, underlining that it is in low-income countries where the most significant difficulties have been encountered [4].

In addition, Cerci et al. demonstrated a significant decrease in the number of cardiac diagnostic procedures performed in Latin America during the COVID-19 pandemic [12]. They noticed the greatest decline occurred in the month with the lowest morbidity (April 2020), which coincided with each country's strictest quarantine periods. In light of these findings, it's essential to highlight the relevance of each country's particular disease burden and their impact on physicians' barriers perception.

Our data suggest that contemporary cardiology needs to undergo a significant paradigm shift. As a result of the ongoing crisis, it has become necessary to introduce changes in the strategies applied to diagnosis and therapeutic evaluation of CAD, emphasizing the development of efficient telemedicine systems, especially in poorer countries and remote areas. Such transformative health systems can provide sustainable, low-cost care, even after the pandemic has receded. They may also call for revision of the appropriateness of current levels of diagnostic testing in some countries and lead to more selective use [13].

Although, we understand that the impact, disease burden and practice patterns towards COVID-19 varies from country to country, we decided to group countries by region for analytical purposes, since the majority of SISIAC members practice on those nations. Hence, caution must be exercised when interpreting our results.

In this survey, almost half of respondents acknowledged that the pandemic prompted them to modify their approach to CAD, including invasive modalities in the diagnosis and percutaneous therapy of ACS. As previously shown in other studies, patients' follow-up was also hampered, particularly in low- and middle-income countries [4,13]. Whether these findings contribute to the deeply concerning evidence that points to COVID-19 as the causative factor of the higher rates of CV mortality found in many nations during 2020 remains to be seen, especially in Latin America. The questions in this survey were short and precise, with the unique interest to evaluate physicians' perception. Further research is needed to evaluate specifically how practice patterns changed due to COVID-19 pandemic and the rationale behind those changes in the diagnostic approach of ischemic heart disease.

5. Conclusion

Our results suggest that regardless of non-invasive or invasive approaches, the pandemic has significantly impacted the clinical management of CAD according to physicians' perception. Reduced access to telemedicine, lower availability of diagnostic methods, and sociocultural factors may explain these findings.

Given the already limited health care scenarios prevalent in Latin America, the potential impact of the pandemic in the CV patient population is indeed concerning. As such, professional societies ought to develop evidence-based, cost-effective protocols in CAD management.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. We received no funding or grant for it's conception or implementation.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcha.2022.101015.

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