



Analysis of the restoration of cardiology diagnostics scope in the Russian Federation during the COVID-19 pandemic: results of the Russian segment of the INCAPS COVID 2 study under the auspices of the International Atomic Energy Agency

Ansheles A. A.¹, Sergienko V. B.¹, Sinitsyn V. E.², Vakhromeeva M. N.³, Kokov A. N.⁴, Zavadovsky K. V.⁵, Ryzhkova D. V.⁶, Karalkin A. V.⁷, Shurupova I. V.⁸, Pospelov V. A.⁹, Migunova E. V.¹⁰, Sayfullina G. B.¹¹, Dary O. Yu.⁸, Zhuravlev K. N.¹², Itskovich I. E.¹³, Gagarina N. V.¹⁴, Hirschfeld C.^{15,16}, Williams M. C.¹⁷, Shaw L. J.¹⁸, Malkovskiy E.^{15,19,20}, Better N.²¹, Cerci R.²², Dorbala Sh.²³, Karthikeyan G.²⁴, Pascual T. N. B.²⁵, Villines T. C.²⁶, Vitola J. V.²², Cohen Y.²⁷, Randazzo M.¹⁵, Sewanan L.¹⁵, Pynda Y.²⁸, Dondi M.²⁸, Paez D.²⁸, Einstein A. J.^{15,19,29} on behalf of the INCAPS COVID research group

Aim. To assess the changes in cardiology diagnostics scope in the Russian Federation during the coronavirus disease 2019 (COVID-19) pandemic.

Material and methods. In an online survey organized by the Division of Human Health of the International Atomic Energy Agency (IAEA), including questions about changes in the workflow of diagnostic laboratories and the scope of cardiac diagnostics from March 2019 (pre-pandemic) to April 2020 (first wave of the pandemic) and April 2021 (recovery stage), 15 Russian medical centers from 5 cities took part.

Results. The decrease in the diagnostics scope by April 2020 by 59,3% compared to March 2019, by April 2021, stopped and was replaced by growth (+7,1%, the recovery rate, 112,1%). The greatest increase was in routine examinations, such as echocardiography (+11,6%), stress echocardiography (+18,7%), stress single photon emission computed tomography (+9,7%), and to a lesser extent resting computed tomography angiography (+7,0%) and magnetic resonance imaging (+6,6%). The performance of stress electrocardiography, stress magnetic resonance imaging and positron emission tomography for the diagnosis of endocarditis in April 2021 compared to March 2019 decreased by 10,3%, 63,2% and 62,5%, respectively.

Conclusion. Due to the resumption of patient admissions for cardiac examinations during the ongoing COVID-19 pandemic, with the anti-epidemic measures taken and certain changes in the workflow, there has been a recovery in the diagnostics scope in most of the included centers.

Keywords: COVID-19, cardiology diagnostic tests.

Relationships and Activities: none.

¹E. I. Chazov National Medical Research Center of Cardiology, Moscow, Russia; ²Lomonosov Moscow State University, Moscow, Russia; ³Pirogov Russian National Research Medical University, Moscow, Russia; ⁴Research Institute for Complex Issues of Cardiovascular Diseases, Kemerovo, Russia; ⁵Cardiology Research Institute, Tomsk, Russia; ⁶Almazov National Medical Research Center, St. Petersburg, Russia; ⁷Pirogov City Clinical Hospital № 1, Moscow, Russia; ⁸Bakulev National Medical Research Center of Cardiovascular Surgery, Moscow, Russia; ⁹City Clinical Hospital № 31, St. Petersburg, Russia; ¹⁰Sklifosovsky Research Institute for Emergency Medicine, Moscow, Russia; ¹¹Interregional Clinical Diagnostic Center, Kazan, Russia; ¹²I. V. Davydovsky City Clinical Hospital, Moscow, Russia; ¹³I. I. Mechnikov North-Western State Medical University, St. Petersburg, Russia; ¹⁴I. M. Sechenov First Moscow State Medical University, Moscow, Russia; ¹⁵Department of Medicine, Columbia University Irving Medical Center and New York-Presbyterian Hospital, New York, NY, USA; ¹⁶Division of Cardiology, Weill Cornell Medical College and New York-Presbyterian Hospital, New York, NY, USA; ¹⁷BHF Center for Cardiovascular Science, University of Edinburgh, Edinburgh, United Kingdom; ¹⁸Blavatnik Family Women's

Health Research Institute, Mount Sinai Medical Center, New York, NY, USA; ¹⁹Seymour, Paul, and Gloria Milstein Division of Cardiology, Columbia University Irving Medical Center and New York-Presbyterian Hospital, New York, NY, USA; ²⁰Columbia College, Columbia University, New York, NY, USA; ²¹Departments of Nuclear Medicine and Cardiology, Royal Melbourne Hospital and University of Melbourne, Melbourne, Australia; ²²Quanta Diagnostico por Imagem, Curitiba, Brazil; ²³Departments of Medicine and Radiology, Brigham and Women's Hospital, Boston, MA, USA; ²⁴All Indian Institute of Medical Sciences, New Delhi, India; ²⁵Philippines Nuclear Research Institute, Manila, Philippines; ²⁶Division of Cardiology, University of Alberta, Edmonton, Alberta, Canada; ²⁷Technion Israel Institute of Technology, Haifa, Israel; ²⁸Division of Human Health, International Atomic Energy Agency, Vienna, Austria; ²⁹Department of Radiology, Columbia University Irving Medical Center and New York-Presbyterian Hospital, New York, NY, USA.

Ansheles A. A.* ORCID: 0000-0002-2675-3276, Sergienko V. B. ORCID: 0000-0002-0487-6902, Sinitsyn V. E. ORCID: 0000-0002-5649-2193, Vakhromeeva M. N. ORCID: 0000-0002-2268-6969, Kokov A. N. ORCID: 0000-0002-7573-0636, Zavadovsky K. V. ORCID: 0000-0002-1513-8614, Ryzhkova D. V. ORCID: 0000-0002-7086-9153, Karalkin A. V. ORCID: 0000-0002-7555-6308, Shurupova I. V. ORCID: 0000-0002-2154-474X, Pospelov V. A. ORCID: none, Migunova E. V. ORCID: 0000-0001-7521-487X, Sayfullina G. B. ORCID: 0000-0002-1259-0285, Dary O. Yu. ORCID: 0000-0003-0140-8166, Zhuravlev K. N. ORCID: 0000-0003-1733-267X, Itskovich I. E. ORCID: 0000-0001-8352-3955, Gagarina N. V. ORCID: 0000-0003-4563-3277, Hirschfeld C. ORCID: 0000-0001-6421-548X, Williams M. C. ORCID: 0000-0001-5807-5281, Shaw L. J. ORCID: 0000-0003-1268-1491, Malkovskiy E. ORCID: 0000-0002-9027-7497, Better N. ORCID: none, Cerci R. ORCID: 0000-0002-3913-7181, Dorbala Sh. ORCID: 0000-0003-1462-1185, Karthikeyan G. ORCID: 0000-0002-2073-2917, Pascual T. N. B. ORCID: none, Villines T. ORCID: 0000-0003-2674-3702, Vitola J. V. ORCID: none, Cohen Y. ORCID: none, Randazzo M. ORCID: 0000-0002-7998-2582, Sewanan L. ORCID: 0000-0003-2629-1865, Pynda Y. ORCID: none, Dondi M. ORCID: 0000-0003-2761-1859, Paez D. ORCID: 0000-0001-9268-0979, Einstein A. J. ORCID: 0000-0003-2583-9278.

*Corresponding author: a.ansheles@gmail.com

Received: 29.07.2022

Revision Received: 18.08.2022

Accepted: 25.08.2022



For citation: Ansheles A. A., Sergienko V. B., Sinitsyn V. E., Vakhromeeva M. N., Kokov A. N., Zavadovsky K. V., Ryzhkova D. V., Karalkin A. V., Shurupova I. V., Pospelov V. A., Migunova E. V., Sayfullina G. B., Dariy O. Yu., Zhuravlev K. N., Itskovich I. E., Gagarina N. V., Hirschfeld C., Williams M. C., Shaw L. J., Malkovskiy E., Better N., Cerci R., Dorbala Sh., Karthikeyan G., Pascual T. N. B., Villines T., Vitola J. V., Cohen Y., Ranzazzo M., Sewanan L., Pynda Y., Dondi M., Paez D., Einstein A. J. Analysis of the restoration of cardiology diagnostics scope in the Russian Federation during the COVID-19 pandemic: results of the Russian segment of the INCAPS COVID 2 study under the auspices of the International Atomic Energy Agency. Impact of the first wave of coronavirus disease 2019 (COVID-19) pandemic on the diagnosis of heart disease in the Russian Federation: results from the IAEA Nuclear Cardiology Protocols Study (INCAPS). *Russian Journal of Cardiology*. 2022;27(9):5170. doi:10.15829/1560-4071-2022-5170. EDN CVJLPD

Key messages

- The scope of diagnostic tests in cardiology in the Russian Federation has recovered after the peak of COVID-19 pandemic.
- It is necessary to maintain a sufficient scope of cardiology diagnostic tests in Russia, not only in patients with coronary artery disease, but in a large new population of patients with cardiovascular consequences of COVID-19.

Introduction

The COVID-19 pandemic has become one of the most important global problems starting in 2020 up to early 2022, affecting all of humanity and having far-reaching social and economic consequences. However, cardiovascular disease (CVD) has been and remains the leading cause of mortality worldwide¹. So, in Russia, even at the peak of the pandemic waves (May 2020, December 2020, July 2021 and November 2021), the mortality from COVID-19 and its consequences was at least 18-20 times lower than the mortality from ischemic heart disease (IHD)². Nevertheless, the COVID-19 pandemic in the Russian Federation has led to the need to transform many large clinics (including federal ones) into "COVID centers." At the same time, the focus of the entire radiology departments has shifted — the volume of chest CT scans to assess COVID-related lung damage has increased dramatically [1], with the simultaneous closure or conservation of most diagnostic departments that performed cardiovascular imaging.

As a result, according to the international INCAPS COVID study, which included data from more than 900 centers in 108 countries around the world, including the Russian Federation, by April 2020 there was a sharp

decrease in the volume of cardiac studies performed [2, 3]. These data were regarded by the coordinators of this study as alarming [2], and even then it was suggested that a sharp restriction in the availability of cardiac studies would entail uncertainty, postponing or even abandoning the necessary interventions and therapeutic decisions, which even in the short term would negatively affect the long-term risk of cardiovascular complications and mortality [4].

As the first wave of COVID-19 faded (by summer-autumn 2020), healthcare institutions around the world gradually resumed cardiac procedures, despite the need to comply with a number of anti-epidemic measures, as well as taking into account certain economic and psychological factors of work in new conditions affecting both healthcare staff and patients. Thus, the INCAPS COVID coordinators initiated the second phase of this study, dedicated to assessing the recovery of diagnostic procedure volumes in cardiology during the ongoing COVID-19 pandemic, including an assessment of changes in the workflow structures, patient admission procedures, procedure protocols, and staffing policies of medical centers taking into account new anti-epidemic measures. Worldwide trends have been characterized recently, and the present paper focuses on characterizing cardiac diagnostic testing in the Russian Federation [5].

Material and methods

The database for sub-analysis was formed as part of the INCAPS COVID 2 study under the auspices of the IAEA. Data was collected using a questionnaire form using a secure software IAEA IRIS platform (<https://iris.iaea.org>). The form of the online questionnaire was developed by a group of specialists in the field of cardiology and cardiovascular imaging [1]. The questionnaire included points regarding changes in the structure of workflow processes compared to the pre-pandemic era, including changes in patient admission, study protocols, staff workflow, as well as the economic and psychological consequences of COVID-19. Changes in the volume of cardiac procedures were assessed in connection with the epidemiological improvement by April 2021 compared to

¹ <https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-cvds>.

² <https://rosstat.gov.ru>, <https://стопкоронавирус.рф>.

Table 1

Provision of protective equipment in healthcare facilities during the COVID-19 pandemic

	Always been sufficient	Insufficient at times, more available in 2021 than 2020	Insufficient at times, similar in 2021 and 2020	Insufficient at times, less available in 2021 than 2020	Never available
Surgical masks	15 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
N95/KN95/KF94/FFP2 masks	4 (26.7%)	7 (46.7%)	1 (6.7%)	1 (6.7%)	2 (13.3%)
Gloves	14 (93.3%)	1 (6.7%)	0 (0%)	0 (0%)	0 (0%)
Gowns	9 (60.0%)	5 (33.3%)	0 (0%)	1 (6.7%)	0 (0%)
Eye shielding	8 (53.3%)	3 (20.0%)	1 (6.7%)	3 (20.0%)	0 (0%)

the same period of 2020, namely the volume of nuclear studies (single-photon, SPECT, and positron emission tomography, PET), CT (including evaluation of coronary calcium and CT-angiography), echocardiography, cardiac MRI, endocarditis cardiac PET, as well as invasive coronary angiography (ICA). The recovery rate was calculated as $(1 - ((N_{03.19} - N_{04.21}) / (N_{03.19} - N_{04.20}))) \times 100\%$, where N is the number of studies for the specified month. The involvement of Russian centers in the study was carried out through invitations from national coordinators with the participation of the Moscow Regional Society of Nuclear Medicine and the Russian Society of Radiology. The participation of research centers was voluntary. No personal or confidential data was collected, so the study did not require approval from ethics committees. Statistical analysis was performed using built-in descriptive statistics of Microsoft Excel 2013.

Results

The data of the Russian Federation are presented by questionnaires from 15 medical centers, including 9 from Moscow, 3 from St. Petersburg, and 1 each from Tomsk, Kazan, and Kemerovo. All included centers were specialized or multidisciplinary hospitals, of which 13 were teaching institutions. These 15 centers included 9 federal centers and 6 city health care institutions, with a capacity of 165 to 1300 (median — 400) beds. Of the 15 institutions, 10 had nuclear medicine departments (including 2 with PET), 13 had CT (including as part of hybrid SPECT/CT or PET/CT systems), and 12 performed stress tests on an ongoing basis. The level of protective equipment provision in medical institutions during the COVID-19 pandemic is shown in Table 1.

A summary of the frequency of implementation of various measures related to workflow changes after 1 year

Table 2

Frequency of implementation of various measures related to workflow changes in the context of COVID-19

	Currently using	Has used but not currently using	Has not used
Changes in workflow structure compared to the pre-COVID era			
Extended hours compared to pre-pandemic	3 (20%)	4 (27%)	8 (53%)
New weekend hours compared to pre-pandemic	2 (13%)	3 (20%)	10 (67%)
Reduced hours compared to pre-pandemic	1 (7%)	1 (7%)	13 (87%)
Systemic approach to rescheduling/testing patients whose studies were cancelled/postponed due to pandemic	8 (53%)	3 (20%)	4 (27%)
Use telehealth for patient interaction aspects (registration, consent)	7 (47%)	2 (13%)	6 (40%)
Use remote reading/reporting of studies (telehealth)	6 (40%)	2 (13%)	7 (47%)
Use telehealth for review of studies with referring providers	7 (47%)	1 (7%)	7 (47%)
Changes in policies for patients/visitors			
Alteration in patient transport, eg spacing use of elevators	5 (33%)	4 (27%)	6 (40%)
Change in waiting areas to allow physical distancing	12 (80%)	3 (20%)	0 (0%)
Separate spaces for patients with and without COVID-19	10 (67%)	3 (20%)	2 (13%)
Reduced patient time in waiting room	6 (40%)	5 (33%)	4 (27%)
Limitation of accompanying family members and/or visitors	12 (80%)	3 (20%)	0 (0%)
Temperature measurements for all patients/visitors	14 (93%)	1 (7%)	0 (0%)
Screening questionnaire to all patients/visitors	10 (67%)	3 (20%)	2 (13%)
Test for COVID19 in patients prior to all diagnostic testing	4 (27%)	5 (33%)	6 (40%)
Test for COVID19 in patients prior to some diagnostic testing	6 (40%)	3 (20%)	6 (40%)
Require cloth/surgical mask for all patients/visitors	15 (100%)	0 (0%)	0 (0%)

Таблица 2. Продолжение

	Currently using	Has used but not currently using	Has not used
Testing protocol changes			
Pharmacologic stress testing preferred over exercise to reduce the risk of COVID-19 transmission	4 (27%)	1 (7%)	10 (67%)
Allocate additional time for each study to allow for thorough cleaning/disinfection between patients	9 (60%)	6 (40%)	0 (0%)
Expedited imaging protocols (e.g., stress-only SPECT/PET, focused cardiac US, single gadolinium injection for MRI, CT with improved HR control protocols, limited view ICA)	3 (20%)	3 (20%)	9 (60%)
Changes in staff workflow			
Limiting staff proximity to patients	12 (80%)	2 (13%)	1 (7%)
Mandating personal protective equipment	14 (93%)	1 (7%)	0 (0%)
Altering or eliminating protocols requiring close patient contact for extended time	4 (27%)	3 (20%)	8 (53%)
Rotating staff work shifts	3 (20%)	6 (40%)	6 (40%)
Economic impact of COVID-19			
"Temporarily furloughed (placed on unpaid leave) some cardiac testing physicians due to economic crisis from COVID-19"	0 (0%)	2 (13%)	13 (87%)
"Temporarily furloughed (placed on unpaid leave) some cardiac testing staff due to economic crisis from COVID-19"	0 (0%)	0 (0%)	15 (100%)
"Reduced salaries of some imaging physicians due to economic crisis from COVID-19"	0 (0%)	5 (33%)	10 (67%)
"Reduced salaries of some cardiac testing staff due to economic crisis from COVID-19"	0 (0%)	5 (33%)	10 (67%)
"Laid off/fired some cardiac testing physicians due to economic crisis from COVID-19"	0 (0%)	0 (0%)	15 (100%)
"Laid off/fired some cardiac testing staff due to economic crisis from COVID-19"	0 (0%)	0 (0%)	15 (100%)
Testing patients for COVID-19			
	All patients	Just non-vaccinated patients	No patients
Test patients for COVID-19 prior to stress testing	4 (27%)	2 (13%)	9 (60%)
"Test patients for COVID-19 prior to noninvasive cardiac imaging"	4 (27%)	1 (7%)	10 (67%)
"Test patients for COVID-19 prior to transesophageal echocardiography"	8 (53%)	0 (0%)	7 (47%)
"Test patients for COVID-19 prior to diagnostic cardiac catheterization"	11 (73%)	1 (7%)	3 (20%)
Psychological consequences of COVID-19			
	Less than one third	One third to two thirds	Greater than two thirds
"What percentage of non-physician clinical staff in cardiac diagnostic testing would you estimate have excess psychological stress related to the pandemic?"	6 (40%)	3 (20%)	6 (40%)
"What percentage of physicians in cardiac diagnostic testing would you estimate have excess psychological stress related to the pandemic?"	8 (53%)	3 (20%)	4 (27%)
	Low	Moderate	Significant
"How has pandemic-related psychological stress in staff members impacted patient care in your cardiac diagnostic testing practice?"	12 (80%)	2 (13%)	1 (7%)

of ongoing COVID-19 pandemic (as measured in April 2021) is given in Table 2.

In general, the volume of cardiac diagnostic procedures in the included Russian centers decreased by 59.3% between March 2019 and April 2020. After 1 year, the total number of studies increased by a total of 7.1% compared to pre-COVID rates (March 2019), as shown in Table 3.

The number of nuclear cardiac studies over the three measured time periods is shown in Figure 1. The dynamics of the decrease and recovery of the volume of functional procedures in April 2020 and 2021 compared to March 2019 is shown in Figure 2A, and the same is shown for other cardiac studies performed at rest in Figure 2B.

Discussion

The COVID-19 pandemic has had a huge impact on the healthcare industry worldwide. Initiated by the Division of Human Health of the International Atomic Energy Agency (IAEA), the large international study INCAPS COVID, which included data from 909 medical centers from 108 countries, showed an unprecedented decrease in cardiovascular diagnostic testing across the globe — by 42% in March 2020 and by 64% in April 2020 compared to March 2019 [2]. In Europe, the complex of measures taken to deal with COVID-19 varied significantly depending on the severity of the situation in different countries and regions, but the total number of cardiac examinations also decreased — by 45% in March 2020 and by 69% in April 2020.

Table 3

**Changes in volume of cardiological examinations performed in Russia,
comparing April 2020 and April 2021 to March 2019**

	Russia			Overall
	Moscow	St. Petersburg	Regions*	
Number of centers	9	3	3	15
Changes in the volume of all studies				
03.2019-04.2020	-70.9%	-63.0%	-43.8%	-59.3%
03.2019-04.2021	+18.0%	+8.4%	-7.0%	+7.1%
Recovery rate	125.3%	113.4%	84.1%	112.1%
Changes in the volume of myocardial perfusion SPECT				
03.2019-04.2020	-91.8%	-94.7%	-15.5%	-66.6%
03.2019-04.2021	+10.9%	+21.1%	+6.6%	+9.7%
Recovery rate	111.9%	122.2%	142.6%	114.5%

Note: * — regions: Tomsk region, Kemerovo region, Tatarstan.

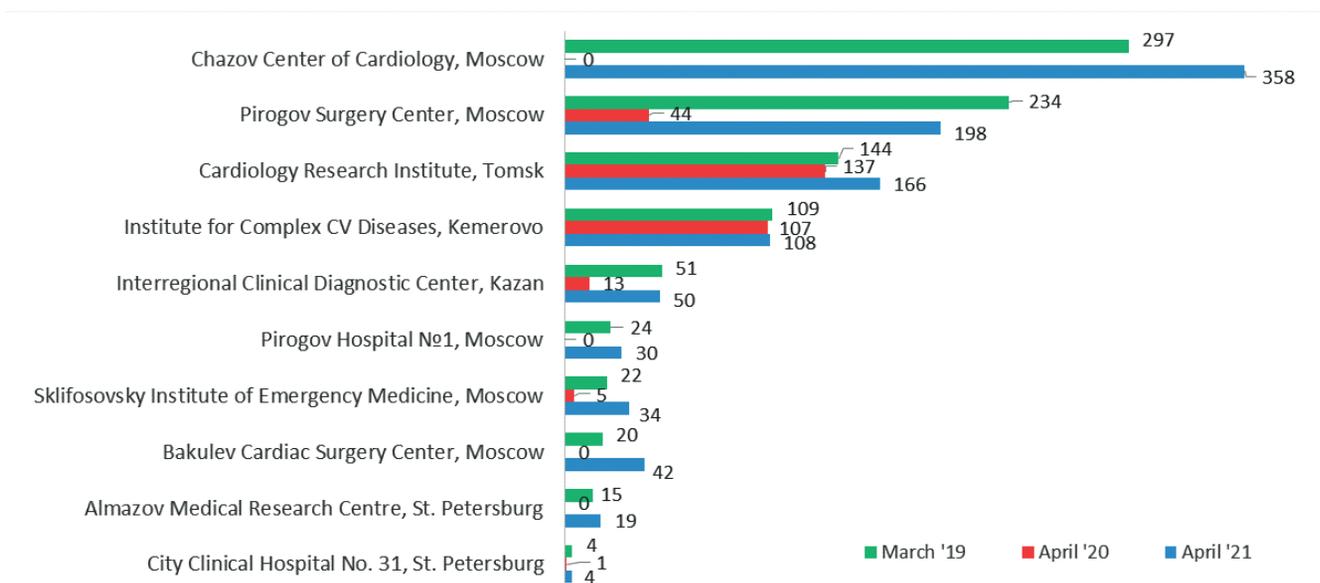


Figure 1. Dynamics of the volume of nuclear cardiac studies in various centers of Russia in March 2019, April 2020, and April 2021.

In Russia, during the first wave of the COVID-19 pandemic, 7 out of the 8 included federal centers were transformed into "COVID-centers", which, together with other changes in the internal regulations related to COVID-19, led to many changes in the workflow of diagnostic laboratories. In 80% of centers in Russia, the volume of outpatients decreased (for comparison, Europe saw a decrease in 85% of centers, $p=0.89$). Meanwhile, in 4 centers, the admission of patients for nuclear procedures has completely stopped [3].

In those centers where there was a residual flow of patients, a number of restrictive rules were introduced. Measures were also taken to modify study protocols to minimize the potential for infection of patients and staff in the workplace. According to our data, as of April 2020, the frequency of implementation of these changes in Russia differed sufficiently from European practice. In

particular, in Russia, switching to remote communication with patients was less frequent, and modifying patient transportation methods and patient flow logistics in the premises of diagnostic departments was less common. Apparently, this was due to the fact that at the time of filling out these questionnaires (end of May '20), a significant part of the diagnostic laboratories was closed, and the new anti-epidemic rules were introduced later, as the outpatient flow gradually resumed. By the autumn of 2020, most of the centers that were repurposed as COVID-centers during the first COVID-19 wave returned to their main activities, and diagnostic laboratories were for the most part reactivated and resumed receiving patients in the context of a full-fledged second wave of the pandemic. As of April 2021, most of the anti-epidemic rules and restrictions set out in the internal regulations and orders for institutions have been implemented in

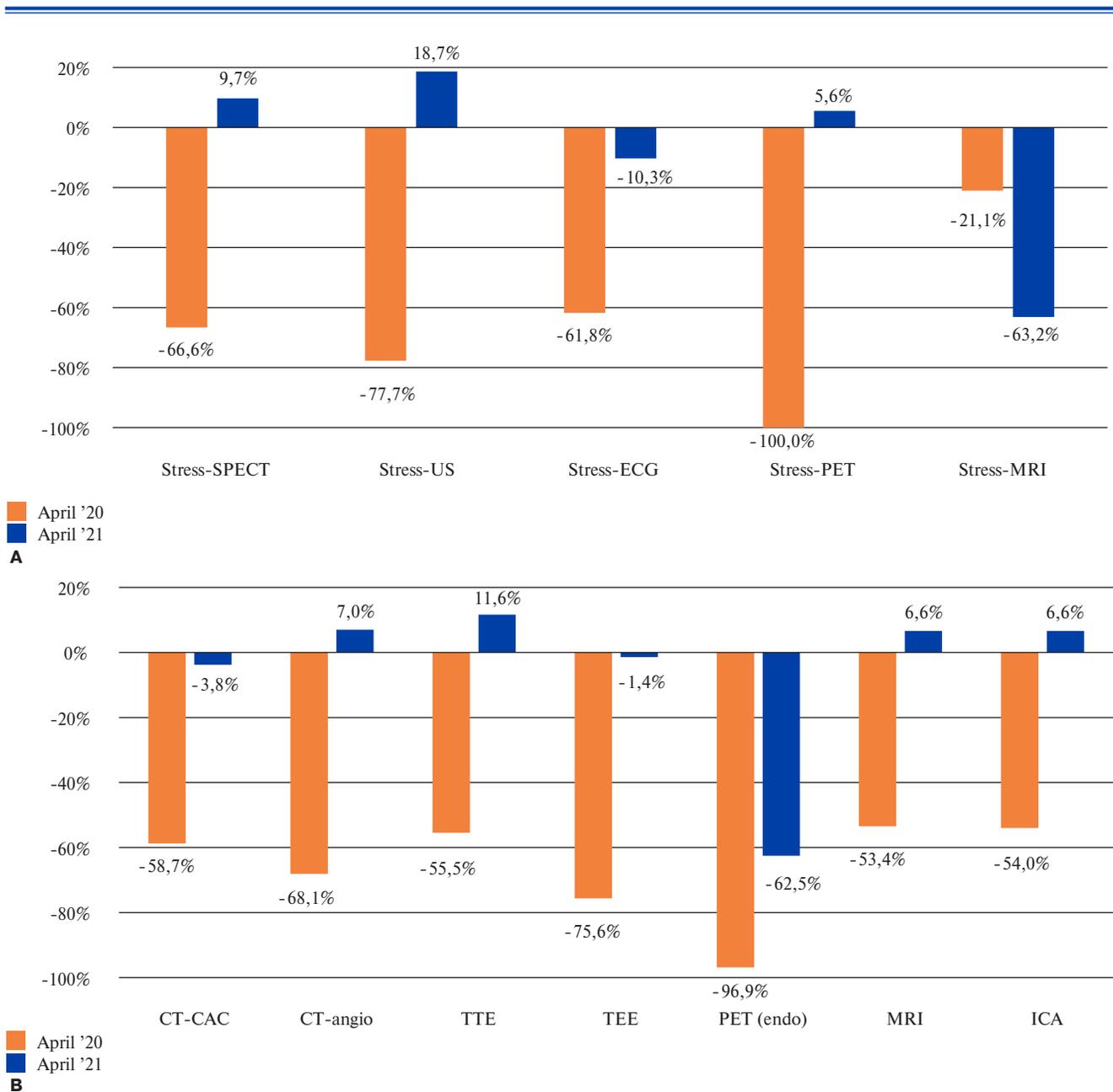


Figure 2. Change in the number of functional (A) and other (B) cardiac examinations in April 2020 and 2021 compared to March 2019.

these institutions on a regular basis (see Table 2). The largest emphasis in these orders was placed on compliance with physical distancing rules and the use of personal protective equipment. In addition, the majority of centers (53%) took systematic measures to optimize scheduling of patients who were actually queued as a result of the temporary closure or re-profiling of diagnostic departments. It should be noted that not all centers introduced mandatory testing of patients for COVID-19. However, in many centers of Russia, the flows of outpatients and inpatients were separated (by organizing separate entrances, exits, and partitions), which was not reflected in the questionnaire provided by the IAEA.

From the point of view of the organization of daily work, we noted that in most centers, in general, there were no significant changes in the diagnostic protocols of cardiac studies, and the negative psychological effects of the pandemic were generally assessed by doctors and other medical staff as low/moderate and practically did not interfere with the performance of labor functions. This, in particular, was facilitated by the resumption by May 2021 of the full provision of both consumables (^{99m}Tc-generators, radiopharmaceutical preparation kits, contrast agents, etc.) and personal protective equipment in the volumes provided for by the institution's internal orders (see Table 1).

According to updated data, in general, the volume of cardiac diagnostic procedures in the involved Russian centers decreased by 59.3% from March 2019 to April 2020. At the same time, in the regions, the decrease in the volume of studies, including myocardial perfusion SPECT, was not so pronounced compared to Moscow and St. Petersburg (Table 3). This was due to the fact that in the regions, the incidence of COVID-19 had not yet reached its peak by April 2020 and did not require the same strict measures as in Moscow and St. Petersburg. After 1 year, the total number of studies in the Russian Federation increased by 7.1% compared to pre-COVID rates (Table 3). The largest increase in the number of procedures by April 2021 is in Moscow and St. Petersburg, while a slight decrease continued in the regions (-7.0%, recovery rate — 84.1%). This appears to be also due to the delayed effects of the COVID-19 pandemic in the regions. There was a further decrease in the number of studies such as stress-MRI (-63.2%) and PET for the diagnosis of endocarditis (-62.5%), which, apparently, is associated with their high cost. On the other hand, routine and less expensive examinations showed the largest increase, such as echocardiography (+11.6%), stress echocardiography (+18.7%), stress-SPECT (+9.7%), and to a lesser extent CT-angiography (+7.0%) and rest MRI (+6.6%). At the same time, the volume of myocardial perfusion SPECT in particular showed an increase in all regions. The growth in the number of myocardial scintigraphy was the largest in those centers where a stable flow of patients was established for a long time within the framework of regional compulsory medical insurance funds or by internal orders. In these centers, after the restrictions on outpatient admission were lifted, the flow of patients for myocardial scintigraphy was quickly restored.

Study limitations. This is a self-reported survey, therefore there is the possibility of selection and nonresponse bias, recall bias, unverified answers, and incomplete data, thus making the data collected subject to multiple potential sources of inaccuracy. The findings from the 15 centers in Russian Federation included in the analyses may

not entirely reflect the rest of centers (presumably no more than 5) that were not part of the study. However, extensive attempts were made to include as many centers as possible. Each site's use of cardiac testing in April 2021 may reflect to some degree the local severity of the pandemic at that time, and this was not quantified. The data regarding stress-PET and the data on the pandemic's impact on psychological stress were insufficient and was not quantified.

Conclusion

Thus, despite the changes in the workflow of diagnostic departments associated with the COVID-19 pandemic, it should be stated that by now, the consequences of its negative impact on the diagnosis of cardiac diseases have been practically eliminated. The 2020 backlog of rejected patients due to lab closures accounted for a portion of the increase in procedure volume in 2021, and therefore patient flow has returned to normal at most centers. In particular, this also applies to SPECT myocardial perfusion studies. According to our data, the waiting list for this study in patients with suspected or established CAD at the end of 2020 in these centers was at least 500-700 people, and by now this waiting list has practically disappeared. In this regard, we assume that in the future the number of studies may slightly decrease.

However, despite the positive signals showing overcoming not only the COVID-19 pandemic itself, but also its negative impacts on the cardiac imaging industry, we still expect an increase in the impact of the short- and long-term consequences of the COVID-19 pandemic on all patients with cardiovascular diseases [6]. In this regard, it is necessary to maintain a high volume of cardiac studies in the Russian Federation for timely therapeutic and interventional decisions not only in patients with coronary artery disease, but also in a new large population of patients with cardiovascular consequences of COVID-19.

Relationships and Activities: none.

References

1. Sinitsyn VE, Tyurin IE, Mit'kov VV. Temporary conciliatory methodological recommendations of the Russian Society of X-ray and radiologists (RORR) and the Russian Association of Ultrasound Diagnostics specialists in medicine "Methods of radiation diagnostics of pneumonia with a new coronavirus infection COVID-19" (version 2). *Journal of radiology and nuclear medicine*. 2020;101(2):72-89. (In Russ.) doi:10.20862/0042-4676-2020-101-2-72-89.
2. Einstein AJ, Shaw LJ, Hirschfeld C, et al. International Impact of COVID-19 on the Diagnosis of Heart Disease. *J Am Coll Cardiol*. 2021;77(2):173-85. doi:10.1016/j.jacc.2020.10.054.
3. Ansheles AA, Sergienko VB, Sinitsyn VE, et al. The influence of the first wave of the pandemic of the new coronavirus infection (COVID-19) on the volume of diagnostic studies of cardiological diseases in the Russian Federation: the results of the Russian segment of the International Research of INCAPS COVID under the auspices of the International Atomic Energy Agency. *Russian Journal of Cardiology*. 2021;26(1):4276. (In Russ.) doi:10.15829/1560-4071-2021-4276.
4. Knuuti J, Wijns W, Saraste A, et al. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes. *Eur Heart J*. 2019;41(3):407-77. doi:10.1093/eurheartj/ehz425.
5. Einstein AJ, Hirschfeld C, Williams MC, et al. Worldwide Disparities in Recovery of Cardiac Testing 1 Year Into COVID-19. *J Am Coll Cardiol*. 2022;79(20):2001-17. doi:10.1016/j.jacc.2022.03.348.
6. Writing C, Gluckman TJ, Bhavne NM, et al. 2022 ACC Expert Consensus Decision Pathway on Cardiovascular Sequelae of COVID-19 in Adults: Myocarditis and Other Myocardial Involvement, Post-Acute Sequelae of SARS-CoV-2 Infection, and Return to Play: A Report of the American College of Cardiology Solution Set Oversight Committee. *J Am Coll Cardiol*. 2022;79(17):1717-56. doi:10.1016/j.jacc.2022.02.003.

INCAPS COVID 2 Investigators Group

Executive Committee: Andrew J. Einstein (chair), Diana Paez (IAEA section head), Maurizio Dondi (IAEA project lead); (alphabetically) Nathan Better, Rodrigo Cerci, Sharmila Dorbala, Ganesan Karthikeyan, Thomas N. B. Pascual, Leslee J. Shaw, Todd C. Villines, Joao V. Vitola, Michelle C. Williams

Information Technology and Statistics Committee: Yaroslav Pynda (chair); (alphabetically): Gerd Hinterleitner, Yao Lu, Olga Morozova, Zhuoran Xu

Data Coordination Committee: Cole B. Hirschfeld (chair); (alphabetically): Yosef Cohen, Ikenna Erinne, Eli Malkovskiy, Michael Randazzo, Lorenzo Sewanan, Mrinali Shetty

Communications Committee: Andrew Choi (chair); (alphabetically): Juan Lopez-Mattei, Purvi Parwani

Members (alphabetically by country and last name)

Albania: Artan Goda, Ervina Shirka

Algeria: Salah Bouyoucef, Lydia Chelghoum, Farouk Mansouri, Abdelkader Medjahedi, Qais Naili, Mokhtar Ridouh

Argentina: Diego Alasia, Lucia Alberghina, Natalia Aramayo, Diego Buchara, Franco Gabriel Busso, Jose Javier Bustos Rivadero, Jorge Camilletti, Hugo Campanelli, Roxana Campisi, Ricardo Belisario Castro, Mariana Daicz, Horacio del Riego, Laura Dragonetti, Diego Echazarreta, Juan Erriest, Fernando Faccio, Adolfo Facello, Hugo Gallegos, Ricardo Geronazzo, Horacio Glait, Victor Hasbani, Victor Jäger, Julio Manuel Lewkowicz, Jose Lotti, Neiva Maciel, Osvaldo Masoli, Edgardo Mastrovito, Maria Medus, Maria Fernanda Merani, Susana Molteni, Marcos Montecinos, Gustavo Parisi, Claudio Pereyra Sueldo, Diego Perez de Arenaza, Luis Quintana, Alejandro Radzinski, Marcela Redruello, Marina Rodríguez, Horacio Rojas, Arturo Romero Acuña, Daniel Schere, Sonia Traverso, Gustavo Vazquez, Susana Zeffiro

Armenia: Mari Sakanyan

Australia: Scott Beuzeville, Raef Boktor, Michael Crowley, D'Arne Downie, Girish Dwivedi, Barry Elison, Omar Farouque, Kim Jasper, Subodh Joshi, Joseph Lee, Kenneth Lee, Elaine Lui, Peter Mcconachie, Joanne Meaker, Dee Nandurkar, Johanne Neill, Edward O'Rourke, Patricia O'Sullivan, George Pandos, Manuja Premaratne, David Prior, Natalie Rutherford, Connor Saunders, Kim Taubman, Andrew Tauro, Andrew Taylor, James Theuerle, Paul Thomas, Jonathan Tow, Anthony Upton, Shankar Vamadevan, Victor Wayne, Eva Alina Wegner, David Wong, John Younger

Austria: Dietrich Beitzke, Gudrun Feuchtner, Oliver Sommer, Konrad Weiss

Belarus: Natallia Maroz-Vadalazhskaya, Uladzimir Tserakhau

Belgium: Filip Homans, Caroline M. Van De Heyning

Bolivia: Raúl Araujo

Bosnia and Herzegovina: Valentina Soldat-Stankovic, Sinisa Stankovic

Brazil: Augusto Almeida, Carlos Anselmi, Guilherme S.A. Azevedo, Marcio Sommer Bittencourt, Diego Bromfman Pianta, Estevan Cabeda, Lara Carreira, Rodrigo Cerci, Igor Coelho, Fernando de Amorim Fernandes, Andrea de Lorenzo, Roberta Delgado, Fernanda Erthal, Fabio Fernandes, Juliano Fernandes, Thiago Ferreira de Souza, Murilo Foppa, Wilson Furlan Matos Alves, Cibele Gontijo, Ilan Gottlieb, Gabriel Grossman, Maria Helena Albernaz Siqueira, Cesar Higa Nomura, Katia Hiromoto Koga, Ronaldo Lima, Rafael Lopes, Hugo Humberto Marçal Filho, Paulo Masiero, Luiz Mastrocola, Maria Eduarda Menezes de Siqueira, Claudio Mesquita, Danilo Naves, Filipe Penna, Ibraim Pinto, Thércio Rocha, Juliana Leal Rocha, Alfredo Rodrigues, Leila Salioni, Adelina Sanches, Marcelo Santos, Leonardo Sara Da Silva, Paulo Schwartzman, Cristina Sebastião Matushita, Tiago Senra, Marcelo Silva, Carlos Eduardo Soares, Bernardo Spiro, Carlos Eduardo Suaide Silva, Rafael Torres, Guilherme Urpia Monte, Andrea Vilela, Alexandre Volney Villa, Joao Vitola, Themissa Voss, Roberto Waltrick, Marcello Zapparoli

Brunei Darussalam: Hamid Naseer

Bulgaria: Marina Garcheva-Tsacheva

Burkina Faso: Tiémégna Florence Ouattara

Cambodia: Sarameth Thou, Soley Varoeun

Canada: Gad Abikhzer, Rob Beanlands, Michael Chetrit, Dominique Dabreo, Carole Dennie, Matthias Friedrich, Mohammed Nassoh Hafez, Kate Hanneman, Robert Miller, Anastasia Oikonomou, Idan Roifman, Gary Small, Vikas Tandon, Adwait Trivedi, James White, Katherine Zukotynski

Chile: Rita Alay, Carmen Concha, Teresa Massardo

Colombia: Pedro Abad, Kelly Anzola, Harold Arturo, Luis Benitez, Alberto Cadena, Carlos Caicedo Zamudio, Antonio Calderón, Claudia T. Gutierrez Villamil, Claudia Jaimes, Juan L. Londono, Nelson Lopez, Sonia Merlano-Gaitan, Ramon Murgieitio-Cabrera, Manuel Valencia, Damiana Vergel, Alejandro Zuluaga Santamaria

Costa Rica: Felix Solis

Croatia: Tonci Batinic, Maja Franceschi, Maja Hrabak Paar, Marina Prpic

Cuba: Juan Felipe Batista, Lazaro Omar Cabrera, Amalia Peix, Yamilé Peña, Luis Manuel Rochela Vázquez

Cyprus: Ioannis Ntalas

Czech Republic: Milan Kaminek, Vladimir Kincl, Otto Lang

Denmark: Jawdat Abdulla, Morten Böttcher, Martin Busk, Uka Geisler, Lars C. Gormsen, Nicolaj Hansson, Søren Hess, Jens Hove, Lars Thorbjørn Jensen, Magnus T. Jensen, Kristian Hay Kragholm, Bjarne L. Nørgaard, Kristian Øvrehus, Jan Rasmussen, Niels Peter Rønnow Sand, Hanne Sondergaard, Tomas Zaremba

- Dominican Republic:** Herwin Speckter
- Ecuador:** Nelson Amores, Mayra Sanchez Velez
- Egypt:** Taghreed Abd Alrahman, Sherif Abd Elsamad, Alia Abdelfattah, Adel Allam, Sameh Elkaffas, Mona Hassan, Elshaymaa Hussein, Ahmed Ibrahim, Ahmed Kandeel, Mohamed Mandour Ali, Mahmoud Shaaban
- El Salvador:** Camila Flores, Verónica Vanesa Gómez Leiva
- Estonia:** Anita Liiver
- Finland:** Martti Larikka, Valtteri Uusitalo
- France:** Denis Agostini, Clothilde Berger, Matthieu Dietz, Fabien Hyafil, Mickaël Ohana, Kevin Prigent, Hamza Regaieg, Laure Sarda-Mantel
- Germany:** Darach O. H-Ici
- Ghana:** Harold Ayetey
- Greece:** George Angelidis, Christina Fraggaki, Chrysoula Fragiadaki, Panagiotis Georgoulas, Maria Koutelou, Elena Kyrozi, Niki Lama, Ioannis Ntalas, Vassilis Prassopoulos, Michael Spartalis, Theodora Zaglavara
- Guatemala:** Carla Gonzalez, Goleat Gutierrez
- Honduras:** Alejandro Maldonado, Yassine Martinez
- Hungary:** Attila Kovács, Bálint Szilveszter
- India:** Nilesh Banthia, Vivek Bhat, Mona Bhatia, Partha Choudhury, Vijay Sai Chowdekar, Johann Christopher, Tushar Garg, Naresh Kumar Goyal, Ripen Kumar Gupta, Abhishek Gupta, Julie Hephzibah, Shashank Jain, Jesu Krupa, Parveen Kumar, Sukriti Kumar, Arati Lalchandani, Animesh Mishra, Vivaswan Dutt Mishra, Parul Mohan, Ahmad Ozair, Shivani Pandey, Ramanathapuram Parameswaran, Chetan Patel, Tapan Patel, Shivani Patel, Leena Robinson Vimala, Pradosh Kumar Sarangi, Shantanu Sengupta, Arvind Sethi, Amit Sharma, Awadhesh Kumar Sharma, Punit Sharma, Apurva Shrigiriwar, Santosh Singh, Harpreet Singh, Ashwani Sood, Atul Verma, Ajay Vyas
- Indonesia:** Erwin Affandi Soeriadi, Edison Bun, Febby Hutomo, Hilman Syawaluddin, Ryan Yudistiro
- Iraq:** Amjed Albadr
- Islamic Republic of Iran:** Majid Assadi, Farshad Emami, Alireza Emami-Ardekani, Saeed Farzanehfard, Ramezan Jafari, Reyhaneh Manafi-Farid, Maryam Tajik
- Israel:** Yoav Arnson, Shmuel Fuchs, Ronen Goldkorn, John Kennedy, Marina Leitman, Aryeh Shalev
- Italy:** Wanda Acampa, Domenico Albano, Pierpaolo Alongi, Gaspare Arnone, Roberta Assante, Anna Baritussio, Matteo Bauckneht, Francesco Bianco, Rachele Bonfiglioli, Francesco Bovenzi, Isabella Bruno, Andrea Bruno, Elena Busnardo, Elena Califaretti, Roberta Casoni, Vittorio Censullo, Franca Chierichetti, Marcello Chiocchi, Corrado Cittanti, Alberto Clemente, Alberto Cuocolo, Maria Luisa De Rimini, Giuseppe De Vincentis, Veronica Della Tommasina, Santo Dellegrottaglie, Paola Anna Erba, Laura Evangelista, Lara Faggi, Evelina Faragasso, Luigia Florimonte, Viviana Frantellizzi, Marco Gatti, Angela Gaudiano, Fabrizia Gelardi, Alberto Gerali, Alessia Gimelli, Marco Guglielmo, Lucia Leccisotti, Riccardo Liga, Carlo Liguori, Giampiero Longo, Margherita Maffione, Claudio Marcassa, Giovanni Matassa, Donato Mele, Elisa Milan, Luca Mircoli, Andrea Paccagnella, Sara Pacella, Federica Padovano, Dario Pellegrini, Valeria Pergola, Luca Pugliese, Natale Quartuccio, Lucia Rampin, Fabrizio Ricci, Giuseppe Rubini, Vincenzo Russo, Gianmario Sambuceti, Alessandra Scatteia, Roberto Sciagrà, Gianluca Spidalieri, Antonella Stefanelli, Carlo Tedeschi, Guido Ventroni
- Jamaica:** Dainia Baugh, Ernest Madu
- Japan:** Tadao Aikawa, Hiroshi Asano, Shinichiro Fujimoto, Koichiro Fujise, Yoshimitsu Fukushima, Kae Fukuyama, Yasutaka Ichikawa, Reiko Ideguchi, Nobuo Iguchi, Masamichi Imai, Hayato Ishimura, Satoshi Isobe, Kimiteru Ito, Yu Izawa, Toshiaki Kadokami, Tokuo Kasai, Takao Kato, Takashi Kawamoto, Shigeru Kiryu, Shinichiro Kumita, Osamu Manabe, Hirotaka Maruno, Naoya Matsumoto, Masao Miyagawa, Masao Moroi, Shigeki Nagamachi, Kenichi Nakajima, Ryo Nakazato, Mamoru Nanasato, Masanao Naya, Takashi Norikane, Yasutoshi Ohta, Yoichi Otomi, Hideki Otsuka, Noriko Oyama-Manabe, Masaki Saito, Masayoshi Sarai, Junichi Sato, Daisuke Sato, Shinya Shiraishi, Kentaro Takanami, Kazuya Takehana, Yasuyo Taniguchi, Hiroki Teragawa, Nobuo Tomizawa, Kyoko Umeji, Yasushi Wakabayashi, Shinichiro Yamada, Shinya Yamazaki, Tatsuya Yoneyama
- Jordan:** Mohammad Rawashdeh
- Kazakhstan:** Tairkhan Dautov
- Kenya:** Khalid Makhdomi
- Kuwait:** Mostafa Abass, Masoud Garashi, Qaisar Siraj
- Latvia:** Marika Kalnina
- Lebanon:** Mohamad Haidar
- Lithuania:** Renata Komiagiene, Giedre Kviecinskiene, Donatas Vajauskas
- Malaysia:** Noor Khairiah A. Karim
- Mali:** Mady Doucoure
- Malta:** Luise Reichmuth, Anthony Samuel
- Mauritania:** Mohamed Lemine Dieng
- Mauritius:** Ambedhkar Shantaram Naojee
- Mexico:** Estrella Aguilera Hernandez, Cesar Rene Alducin Tellez, Erick Alexanderson-Rosas, Erika Barragan, Manuel Cabada, Daniel Calderón, Isabel Carvajal-Juarez, José Esparza, Manlio Gerardo Gama-Moreno, Virginia Garcia Quinto, Nelsy Coromoto Gonzalez, Mary Carmen Herrera-Zarza, Aloha Meave, Jesus Gregorio Medina Verdugo, Gabriela Melendez, Rafael Humberto Morales Murguia, Carlos Salvador Navarro Quiroz, Mario Ornelas, Andres Preciado-Anaya, Oscar Ulises Preciado-Gutiérrez, Adriana Puente, Aristóteles Ramírez Salazar, Sandra Graciela Rosales Uvera, Jose Antonio Serna Macias, Lilia M. Sierra-Galan, Juan Carlos Tirado Alderete, Enrique Vallejo
- Monaco:** Marc Faraggi
- Mongolia:** Erdenechimeg Sereegotov
- Morocco:** Nouzha Ben Rais, Nadia Ismaili Alaoui
- Myanmar:** Thiri Kyiphyu, Su Thet Oo, Soe Myat Win, Htin Zar
- Nepal:** Ram Ghimire, Madhu Neupane

Netherlands: Andor Glaudemans, Riemer Slart, Derk Verschure

New Zealand: Berry Allen, John Edmond, Clare Mckenzie, Stuart Tie, Niels Van Pelt, Kirsten Worthington, Calum Young

Niger: Idrissa Adamou Soli

Nigeria: Shehu Kana, Uchenna Onubogu, Mahmoud Sani

Norway: Anders Tjellaug Bråten, Arve Jørgensen, Hanne-Elin Vassbotn

Oman: Humoud Al Dhuhli, Zabah Jawa, Naima Tag

Pakistan: Shazia Fatima, Muhammad Babar Imran, Muhammad Numair Younis, Mohammad Saadullah

Panama: Yariela Herrera Malo

Papua New Guinea: Dora Lenturut-Katal

Paraguay: Manuel Castillo, José Ortellado

People's Republic of Bangladesh: Afroza Akhter, F. Aaysha Cader, Raihan Hussain, Saidur Rahman Khan, Tapati Mandal, Faria Nasreen

People's Republic of China: Yunqiang An, Dianbo Cao, Lianggeng Gong, Yang Hou, Chongfu Jia, Tao Li, Caiying Li, Hui Liu, Wenya Liu, Jinkang Liu, Bin Lu, Ming-Yen Ng, Heshui Shi, Chunxiang Tang, Ximing Wang, Zhaoqian Wang, Yining Wang, Jiang Wu, Yan Yi, Li Yuan, Tong Zhang, Longjiang Zhang

Peru: Edith Chavez, Carlos Cruz, Christian Llontop, Rosanna Morales

Philippines: Paz Abrihan, Asela Bustos-Barroso, Michele Duldulao-Ogbac, Christopher Eduarte, Jerry Obaldo, Alvin Quinon, Belinda San Juan, Carlo Joe San Juan, Marie Rhiamar Sauler-Gomez, Mila Uy

Poland: Magdalena Kostkiewicz, Jolanta Kunikowska, Anna Teresinska, Tomasz Urbanik

Portugal: Nuno Bettencourt, Ricardo Fontes-Carvalho, Cristina Gavina, Lino Gonçalves, Filipe Macedo, Nuno Moreno, Carla Sousa, Ana Teresa Timoteo, Maria João Vidigal

Qatar: Mahmoud Al Heidous, Subramaniyan Ramanathan

Republic of Ireland: Samer Arnous, Said Aytani, Angela Byrne, Tadhg Gleeson, David Kerins, Julie O'Brien

Republic of Korea: Ji-In Bang, Henry Bom, Miju Cheon, Gi Jeong Cheon, Sang-Geon Cho, Chae Moon Hong, Yong Hyu Jeong, Won Jun Kang, Yeon-Koo Kang, Ji-Young Kim, So Won Oh, Young So, Ho-Chun Song, Kyoung Sook Won, Soo Woong Yoo

Republic of North Macedonia: Irena Mitevaska, Marija Vavlukis

Republic of Slovenia: Barbara Gužic Salobir, Monika Štalc

Romania: Theodora Benedek, Marian Pop, Claudiu Stan

Russian Federation: Alexey Ansheles, Olga Dariy, Nina Gagarina, Irina Itskovich, Anatoliy Karalkin, Alexander Kokov, Gulya Marina, Ekaterina Migunova, Viktor Pospelov, Daria Ryzhkova, Guzaliya Sayfullina, Vladimir Sergienko, Irina Shurupova, Valentin Sinitsyn, Margarita Vakhromeeva, Nailia Valiullina, Konstantin Zavadovsky, Kirill Zhuravlev

Saudi Arabia: Rami Abazid, Turki Al Garni, Mirvat Alasnag, Ahmed Aljizeeri, Hamid Amer, Ahmad Amro, Hesham Hamdy, Osama Smettei

Serbia: Dragana Sobic Saranovic, Marina Vljakovic

Singapore: Felix Keng, Jason See

Slovak Republic: Zuzana Berecova, Jana Polakova Mistinova

South Africa: Osayande Evbuomwan, Nerisha Govender, Jonathan Hack, Bawinile Hadebe, Khanyisile Hlongwa, Mitchell Kaplan, Hoosen Lakhi, Katarina Milos, Moshe Modiselle, Stuart More, Ntanganedzeni Muambadzi, Leonie Scholtz

Spain: Manuel Barreiro-Perez, Isabel Blanco, Jordi Broncano, Alicia Camarero, Irene Casáns-Tormo, Javier De Haro, Albert Flotats, Elia García, Ceferino Gutierrez Mendiguchia, Amelia Jimenez-Heffernan, Ruben Leta, Javier Lopez Diaz, Luis Lumbreras Vega, Ana Manovel-Sánchez, Amparo Martinez Monzonis, Bianca Patrut, Virginia Pubul, Ricardo Ruano Perez, Nahla Zeidan

Sri Lanka: Damayanthi Nanayakkara

Sudan: Ahmed Suliman

Sweden: Henrik Engblom, Mustafa Murtadha, Ellen Ostenfeld, Magnus Simonsson

Switzerland: Hatem Alkadhi, Ronny Ralf Buechel, Peter Burger, Christoph Gräni, Christel Kamani, Nadine Kawel-Böhm, Bernd Klaeser, Robert Manka, John Prior

Thailand: Tawika Kaewchur, Benjapa Khiewvan, Arpakorn Kositwattanarek, Sirianong Namwongprom, Tanyaluck Thientunyakit

Turkey: Haluk Burcak Sayman, Mahmut Yüksel

Uganda: Mugisha Julius Sebikali, Emmy Okello

Ukraine: Pavlo Korol, Iryna Noverko, Maryna Satyr

United Kingdom: Tahir Ahmad, Khaled Alfakih, Ivo Andrade, Susan Buckingham, Anda Bularga, John-Paul Carpenter, Graham Cole, David Cusack, Sarojini David, Patrick Davis, Timothy Fairbairn, Arjun Ghosh, Prasad Guntur Ramkumar, Mark Hamilton, Faisal Haque, Benjamin Hudson, Annette Johnstone, V J Karthikeyan, Mike Kay, Mohammad Ali Khan, Jamie Kitt, Chen Sheng Low, Elisa Mcalindon, David Mccreavy, Brian Morrissey, Manish Motwani, Dilip Na, Edward Nicol, Dilip Patel, Jonathan Rodrigues, Chris Rofe, Rebecca Schofield, Thomas Semple, Azeem Sheikh, Apurva Sinha, Deepak Subedi, William Topping, Katherine Tweed, Stephen Richard Underwood, Jonathan Weir-Mccall, Hamed Zuhairy

United States of America: Taimur Abbasi, Shady Abohashem, Sandra Abramson, Mouaz Al-Mallah, Mohan Ashok Kumar, Mallory Balmer-Swain, Daniel Berman, Adam Bernheim, Sabha Bhatti, Robert Biederman, Erik Bieging, Scott Bingham, Stephen Bloom, Sean Blue, Andressa Borges, Kelley Branch, Paco Bravo, Sujatha Buddhé, Matthew Budoff, Renée Bullock-Palmer, Michael Cahill, Candace Candela, Jane Cao, Saurav Chatterjee, Yiannis Chatzizisis, Nita Ray Chaudhuri, Michael Cheezum, Anjali Chelliah, Tiffany

Chen, Marcus Chen, Lu Chen, Andrew Choi, Aalap Chokshi, Jina Chung, Sorin Danciu, William DeSisto, Michael Dilorenzo, Rami Doukky, William Duvall, Maros Ferencik, Cameron Foster, Anthon Fuisz, Michael Gannon, David German, Myron Gerson, Jeffrey Geske, Fadi Hage, Agha Haider, Sofia Haider, Yasmin Hamirani, Karen Hassen, Robert Hendel, Jacqueline Henkel, Stephen Horgan, Mark Hyun, Rajesh Janardhanan, Scott Jerome, Dinesh Kalra, David Kassop, Mona Kinkhabwala, George Kinzfohl, Bernard Koch, Lynne Koweek, Joseph Krepp, Younghoon Kwon, Jay Layer, John Lesser, Steve Leung, Bernadette Lisske, Juan Lopez-Mattei, Kathleen Magurany, Jeremy Markowitz, Brenda Mccullough, Azita Moalemi, Chanan Moffitt, Juan Montanez, Warren Moore, Shamil Morayati, Mahmud Mossa-Basha, Zorana Mrsic, Venkatesh Murthy, Prashant Nagpal, Katarina Nelson, Prabhjot Nijjar, Rupal O'Quinn, Purvi Parwani,

Edward Passen, Toral Patel, Pravin Patil, Amit Pursnani, Nancy Quachang, Mark Rabbat, Pragya Ranjan, Patricia Rodriguez Lozano, Mary Schemmer, Rebecca Seifried, Nishant Shah, Ameer Shah, Sujata Shanbhag, Gaurav Sharma, Robert Skotnicki, Michael Sobczak, Prem Soman, Vincent Sorrell, Monvadi Srichai, Jim Streeter, Leah Strickland, Suliman Suliman, Naghmeh Tebyanian, Dustin Thomas, Randall Thompson, Seth Uretsky, Srikanth Vallurupalli, Marian Vandyck-Acquah, Vikas Verma, Todd Villines, Joseph Weinstein, David Wolinsky, Karolina Zareba, Michael Zgaljardic

Uruguay: Mario Beretta, Rodolfo Ferrando, Miguel Kapitan, Fernando Mut

Uzbekistan: Omoa Djuraev, Gulnora Rozikhodjaeva

Venezuela: Luisa Vera

Vietnam: Binh Duong Duc, Xuan Canh Nguyen, Phuoc Minh Hiep Nguyen