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ORIGINAL RESEARCH

Coronavirus Disease 2019 Catheterization Laboratory Survey

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BACKGROUND: The coronavirus disease 2019 pandemic is expected to affect operations and lifestyles of interventional cardiologists around the world in unprecedented ways. Timely gathering of information on this topic can provide valuable insight and improve the handling of the ongoing and future pandemic outbreaks.

METHODS AND RESULTS: A survey instrument developed by the authors was disseminated via e-mail, text messaging, WhatsApp, and social media to interventional cardiologists between April 6, 2020, and April 11, 2020. A total of 509 responses were collected from 18 countries, mainly from the United States (51%) and Italy (36%). Operators reported significant decline in coronary, structural heart, and endovascular procedure volumes. Personal protective equipment was available to 95% of respondents; however FIT-tested N95 or equivalent masks were available to only 70%, and 74% indicated absence of coronavirus disease 2019 pretesting. Most (83%) operators expressed concern when asked to perform cardiac catheterization on a suspected or confirmed coronavirus disease 2019 patient, primarily because of fear of viral transmission (88%). Although the survey demonstrated significant compliance with social distancing, high use of telemedicine (69%), and online education platforms (80%), there was concern over impending financial loss.

CONCLUSIONS: Our survey indicates significant reduction in invasive procedure volumes and concern for viral transmission. There is near universal adoption of personal protective equipment; however, coronavirus disease 2019 pretesting and access to FIT-tested N95 masks is suboptimal. Although there is concern over impending financial loss, substantial engagement in telemedicine and online education is reported.

Key Words: coronavirus disease 2019 ■ COVID-19 ■ catheterization laboratory ■ survey

The coronavirus disease 2019 (COVID-19) pandemic is expected to profoundly impact medical practice paradigms during the current outbreak and well into the future.[1,2] It presents an unprecedented shift in practice within medical specialties, such as interventional cardiology, that are delivered predominately through direct patient contact. Capturing these changing patterns by surveying interventional cardiologists (ICs) during the pandemic can help establish awareness of best practices and, at the same time, highlight operational shortcomings. Reporting of such timely information can directly impact both current and future protocols and policies governing minimally invasive procedures across diverse specialties and practice settings.[3]

METHODS

Data and methods of this survey will be made available to other researchers upon reasonable request to the corresponding author. The authors created a survey instrument that was disseminated to ICs identified from the Cardiovascular Innovations Foundation electronic database. This English-language survey was conducted between April 6, 2020, and April 11, 2020, and was composed of 40 multiple response questions designed specifically for ICs. The survey covered demographic information, practice type and location, procedure volumes, procedural preferences, catheterization laboratory and hospital protocols, work schedules during the COVID-19

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CLINICAL PERSPECTIVE

What Is New?

- There is a significant reduction in invasive procedure volumes during the coronavirus disease 2019 pandemic.
- Interventional cardiologists are most concerned about the potential for coronavirus disease 2019 viral transmission, and coronavirus disease 2019 pretesting and access to FIT-tested N95 masks are suboptimal.
- There is concern among interventional cardiologists over impending financial loss.

What Are the Clinical Implications?

- Providers are identifying innovative means for contacting patients, such as via telemedicine.
- The findings of this survey may help identify and address improvements that can be made on institutional and personal responses to coronavirus disease 2019 pandemic.

Nonstandard Abbreviations and Acronyms

COVID-19	coronavirus disease 2019
IC	interventional cardiologist

pandemic, access to personal protective equipment, and perceptions of ICs about care of suspected or confirmed COVID-19 patients, potential economic impact, social distancing measures, and engagement with remote patient care through telemedicine and online education portals. The survey instrument was e-mailed once to all 4894 recipients in the Cardiovascular Innovations Foundation database. The survey link was promoted through social media, text messaging, and WhatsApp. The Survey Monkey platform was used to generate the survey questions and to capture and tabulate responses. The survey integrated seamlessly across various computer operating systems and device platforms (computers and handheld devices). No personal health information was collected through this survey. Identity of the respondents remained unknown, and each respondent could complete the questionnaire only once. Pretesting of the survey was conducted with 10 respondents to establish that an average of 6 minutes was required for 100% completion of the survey. After the survey was closed, data were downloaded from the server and analyzed using SPSS v26 (IBM SPSS, Chicago, IL). No institutional review board approval or informed consent was obtained for this survey. Categorical variables were reported as frequencies with their respective percentages with 95% CIs, and comparisons were made using the Pearson χ^2 test where appropriate. Odds ratios (ORs) were computed to compare United States (reference group) with Italy. $P<0.05$ was significant; all tests were 2 sided.

RESULTS

During the survey period, 509 (10.4%) responses were received, each with 100% completion of all survey questions. Average completion time was 5 minutes 50 seconds. Survey analytics indicated that no aborted attempts were made at completing the questionnaire. Of all ICs who completed the survey, 86% were men, 13% were women, and 1% opted to not disclose their sex identity. Of respondents, 45% were between ages 41 and 55 years, 33% were between ages 25 and 40 years, and 22% were aged >55 years. A university hospital was selected as the primary location of work by 38%, a private nonacademic hospital by 27%, a private practice setting by 12%, and Veterans Affairs hospitals by 6%. Approximately 17% selected the "other" option and indicated that they worked for public nonuniversity hospitals. Although responses were received from 18 countries, most were from the United States (51%), followed by Italy (36%), China (4%), and India (2%; Figure 1). A total of 34 US states were represented on the survey.

Invasive procedural volume attributable to COVID-19 pandemic registered a significant decline across coronary, structural heart, and endovascular areas. Of operators, 24% reported a >90% reduction in coronary procedural volume, 30.6% (95% CI, 27.0%–35.3%) in structural (P=0.02), and 25% (95% CI, 21.2%–28.9%) in endovascular (P=0.74). Figure 2 depicts reported data on procedural volumes. A ≥50% reduction in urgent or emergent invasive coronary procedures for acute coronary syndrome indication and ST-segment–elevation myocardial infarction was reported by 25% (95% CI, 21.2%–28.9%) and 27% (95% CI, 23.0%–31.0%) of operators, respectively.

Most (75%) respondents indicated that their catheterization laboratories had instituted formal COVID-19 protocol for selecting and performing elective, urgent, and emergent procedures, whereas 22% (95% CI, 18.5%–25.9%) had an informal understanding, but no formal protocol. The remaining (3%) selected none of the above, and 1% indicated closure of their catheterization laboratory. In addition, 68% (95% CI, 63.7%–72.0%) reported implementation of specific primary percutaneous coronary intervention and thrombolysis criteria for patients with ST-segment–elevation myocardial infarction. Figure 3A depicts details of COVID-19–related arrangements, including designated catheterization rooms for suspected or confirmed COVID-19 patients, specific donning and doffing

Figure 1. Nations represented in the coronavirus disease 2019 catheterization laboratory survey.

procedures for catheterization laboratory personnel, creation or presence of an ante room, and designated hospital wards or units for suspected or confirmed COVID-19 patients. More important, only 27% (95% CI, 23.0%–31.0%) reported routine COVID-19 pretesting of patients referred to the catheterization laboratory.

Access to personal protective equipment was almost universal (95%); however, the type of personal protective equipment available was diverse and is shown in Figure 3B. Notably, FIT-tested N95 or equivalent masks were not available to 30% (95% CI, 23.0%–31.0%) of respondents.

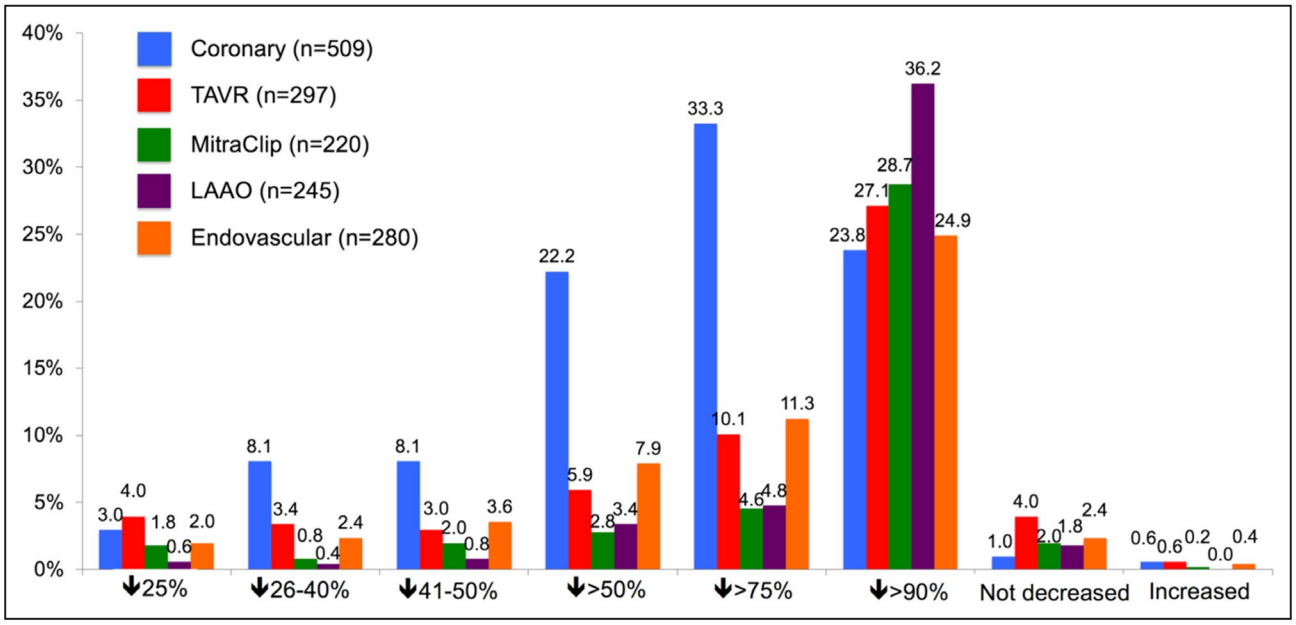

Figure 2. Cardiovascular invasive procedural volumes during the coronavirus disease 2019 pandemic.
Downward arrow indicates decrease; LAAO, left atrial appendage occlusion; and TAVR, transcatheter aortic valve replacement.

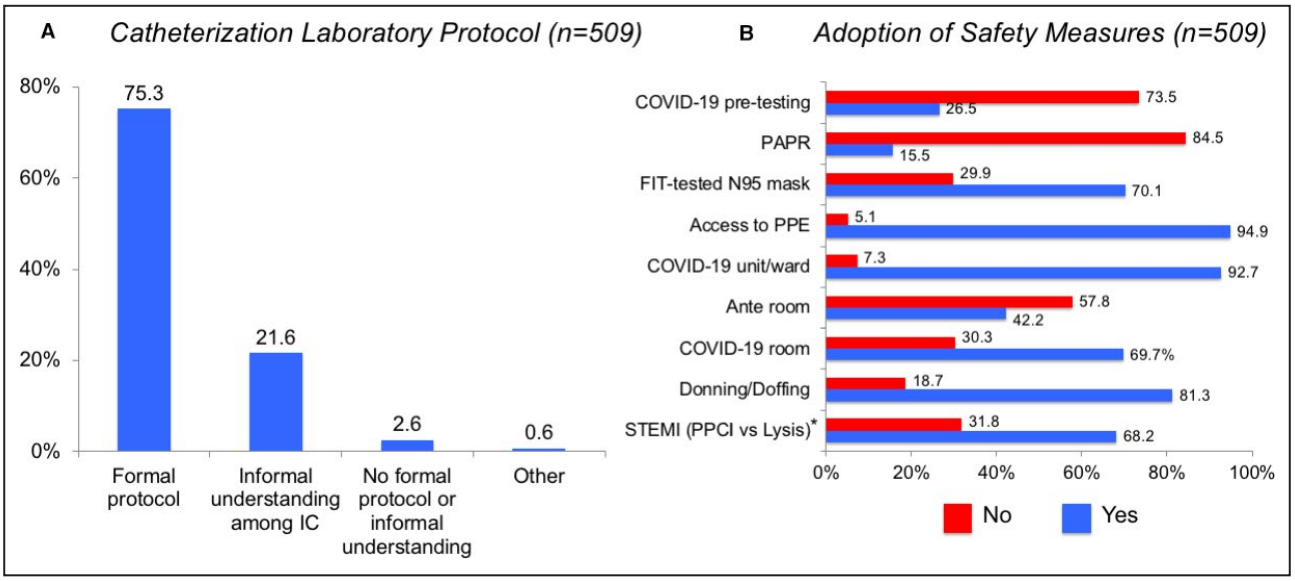

Figure 3. Catheterization laboratory organization during the coronavirus disease 2019 (COVID-19) pandemic.
A, Catheterization laboratory protocol; other response includes catheterization laboratory closed and soon to establish COVID-19 protocol; select one option. **B**, Adoption of safety measures. *Indicates primary percutaneous coronary intervention (PPCI) vs thrombolysis protocol for ST-segment–elevation myocardial infarction (STEMI); multiple selections allowed. IC indicates interventional cardiologist; lysis, thrombolytic therapy; PAPR, powered air-purifying respirator; and PPE, personal protective equipment.

Over half (51%; 95% CI, 46.6%–55.5%) of the respondents claimed to work in an extracorporeal membrane oxygenator capable catheterization laboratory, with specific COVID-19 hemodynamic support criteria in a third (34%; 95% CI, 29.9%–38.3%). Twenty-four–hour access to anesthesiology services for patient

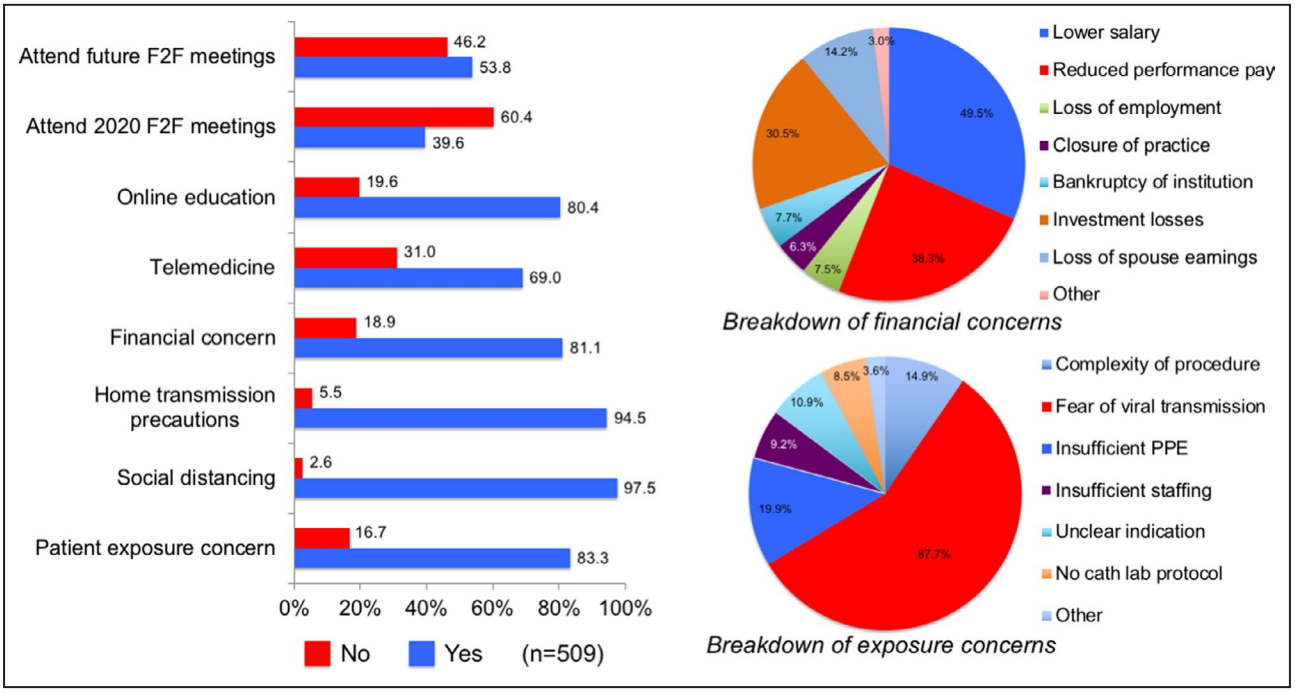

Figure 4. Operator perceptions during the coronavirus disease 2019 (COVID-19) pandemic.
Other responses under breakdown of financial concern include likely increase in taxes, decreased better job prospects, financial recession, and fewer consulting opportunities. Other responses under breakdown of exposure concerns include difficulty in performing procedure while donning personal protective equipment (PPE), lack of negative pressure rooms, and exposure during postprocedure care of COVID-19–infected patients. For breakdown of financial and exposure concerns, multiple selections allowed. Cath indicates catheterization; F2F, face to face; and lab, laboratory.

intubation in the catheterization laboratory was available to 87% (95% CI, 83.8%–89.8%). Access to the Lucas (Jolife AB, Lund, Sweden) chest compression system was available to 29% of respondents, whereas 10% expressed lack of awareness of this device.

Of respondents, 83% expressed concern when asked to perform catheterization in a COVID-19 suspected or confirmed patient, primarily because of fear of viral transmission (88%). A third of operators (34%; 95% CI, 29.9%–38.3%) claimed they would not change their usual procedural plan; however, 18% (95% CI, 14.8%–21.7%) indicated they would take steps to shorten the procedural duration, 17% (95% CI, 13.9%–20.6%) would simplify their percutaneous coronary intervention technique, and 17% would have a lower threshold for endotracheal intubation.

Nearly half of the respondents (46%; 95% CI, 41.6%–50.4%) indicated that their catheterization laboratory weekday and on-call schedules had changed during the COVID-19 pandemic. Although 29% (95% CI, 25.2%–33.2%) had seen no change to their work schedule, 20% (95% CI, 16.6%–23.8%) and 5% (95% CI, 3.2%–7.2%) reported changes to only their weekday or on-call schedules, respectively. Approximately 61% (95% CI, 56.7%–65.4%) reported operators and staff members aged >65 years at their catheterization laboratory; and of those, 21% (95% CI, 17.9%–25.2%) had restricted work of such individuals during the COVID-19 pandemic. Similarly, 41% (95% CI, 36.8%–45.5%) reported restriction of fellows from scrubbing into cases of suspected or confirmed COVID-19 patients.

The survey responses on operator compliance with social distancing, their perceptions about the financial impact of the pandemic, engagement with telemedicine and online educational platforms, and interest in attending face-to-face scientific meetings in 2020 and beyond are shown in Figure 4.

Comparison of the 2 largest groups of operator responses (namely, from the United States and Italy) reveals significantly fewer formal protocols (OR, 1.70; 95% CI, 1.06–2.74; $P<0.03$; Figure 5A) and significantly less frequent COVID-19 pretesting of suspected patients in the United States (OR, 3.48; 95% CI, 2.19–5.52; $P<0.0001$; Figure 5B).

DISCUSSION

Our multinational catheterization laboratory survey conducted during the global COVID-19 pandemic highlights several important practices and perceptions among ICs. First, procedural volumes have dramatically decreased. Second, the pandemic has triggered several important catheterization laboratory operational, personal safety, and scheduling changes. Third, there is often limited access to FIT-tested N95 masks. Fourth, telemedicine and online education have been widely adopted.

This survey, conducted in the midst of the COVID-19 pandemic, is one of the first to capture how the pandemic has affected healthcare workers. Although this survey is focused on interventional cardiology practice, it addresses a diversity of components on operator mindset, practice, and system management that can provide valuable and timely information to minimally invasive proceduralists across a variety of subspecialties. Two healthcare provider surveys conducted during the COVID-19 epidemic were recently published. Guo et al reported on 26 orthopedic surgeons from 8 hospitals in Wuhan, China.[4] The survey identified that severe

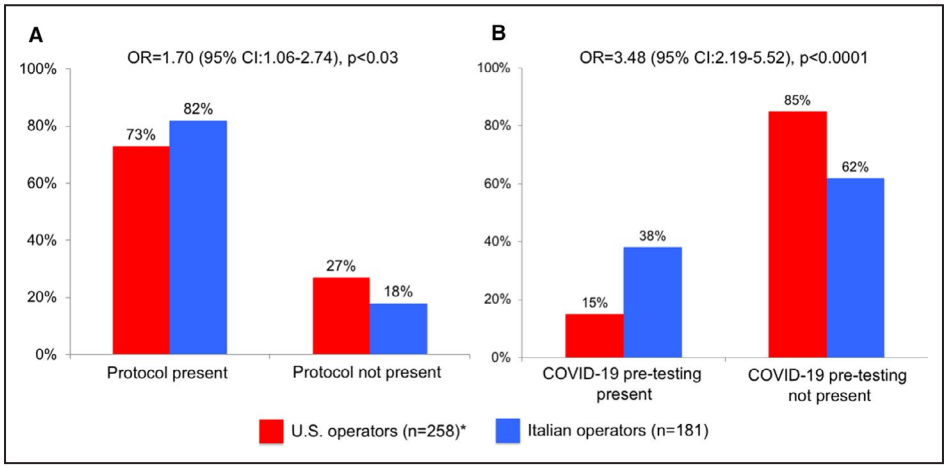

Figure 5. Comparison of US and Italian operator responses.
A, Catheterization laboratory protocols: odds ratio (OR) indicates having a catheterization laboratory coronavirus disease 2019 (COVID-19) protocol was 1.7 times more likely in Italy compared with the United States. **B**, COVID-19 pretesting of suspected patients: OR indicates that COVID-19 pretesting was 3.48 times more likely in Italy compared with the United States. *Reference group.

fatigue and absence of N95 or equivalent masks were risk factors for COVID-19 infection and that health workers had more psychosocial problems than nonmedical health workers during the COVID-19 outbreak. Zhang et al highlighted mental health and psychosocial problems in 2182 Chinese medical and nonmedical healthcare workers during the COVID-19 outbreak.[5] Compared with the above surveys from China, conducted between December 2019 and February 2020, our survey captures a more diverse global perspective. It addresses a broader category of issues, while focusing on interventional cardiology practice.

Our survey indicates a sharp decline in the volume of invasive coronary, structural, and endovascular procedures during the COVID-19 pandemic. The steepest decline is noted in structural procedures, especially left atrial appendage occlusions. As the survey was conducted in the midst of the pandemic in the United States and when it had just started to level off in Italy, the 2 largest contributors to the survey, it indicates a relatively expeditious adoption of measures to streamline catheterization laboratory operations to limit risk of infection to patients and catheterization laboratory staff and maintain essential services for patients.[6,7] Despite these timely interventions, availability of FIT-tested N95 or equivalent masks and pretesting of suspected COVID-19 patients before referral to the catheterization laboratory remain important areas of concern. Recent reports from Italian centers indicate a growing recognition for increased pretesting of suspected COVID-19 patients.[8] This increase in pretesting is not reflected in US operator responses to our survey. The timing of this survey relative to the peak of the pandemic in these respective countries, as well as reduced availability of rapid COVID-19 tests in the United States, may account for these differences. On the basis of recent reports, as such tests become more readily available in the United States, sentinel surveillance in outpatient and inpatient settings can provide a robust approach to monitor and limit COVID-19 transmission.[9] The questions surrounding the availability of N95 or equivalent masks are more uncertain. On the basis of a meta-analysis of randomized controlled trials comparing medical masks with N95 respirators in preventing laboratory-confirmed viral infection, there was low certainty of evidence that medical masks and N95 respirators offer similar levels of protection against viral respiratory infections.[10] Study participants voiced concern about caring for COVID-19 confirmed or suspected patients, mainly because of fear of viral transmission. Availability of FIT-tested N95 or equivalent masks may provide greater assurance of safety to catheterization laboratory staff, improve their psychological preparedness, and ultimately enhance procedural safety for both the patient and providers.[11] The concern for viral transmission among providers can also be gleaned by a near universal adherence to social distancing (97%) and adoption of proactive steps to minimize transmission of infection from workplace to home. Such practices have been shown to have a measurable impact on flattening a pandemic curve.[12]

Our survey also reveals other concerns perceived by ICs. It captures significant financial uncertainty about loss of earnings from lower salaries and reduced incentive or performance pay as hospitals and practices struggle to cope with the economic impacts of the pandemic. There is potentially less concern for lasting economic loss. This can be inferred from a minority of responses (<10%) indicating loss of employment, closure of practices, or bankruptcy of hospitals, medical centers, or outpatient catheterization laboratories. Promising adaptation to the current environment is indicated by the engagement of over two thirds of ICs with telemedicine and online educational platforms. Finally, a dampened enthusiasm to attend face-to-face scientific meetings, despite a lawfully permissive environment, in the year 2020 is reported by 60% of respondents. More than 50% claim that the COVID-19 pandemic will have a more lasting impact on their willingness to attend professional meetings in the coming years. Apprehension to participate in events with large gatherings is a departure from what has become the norm over the past nearly 3 decades of large-scale and well-attended cardiovascular scientific meetings in the United States and around the world. Evidence from influenza pandemics has shown that mass gatherings create environments conducive to the transmission of infectious diseases.[13] In addition, these responses could also be related to concerns over the risks of COVID-19 “stealth” transmission and reinfection past the current period of acute outbreak.[14]

This survey has several important limitations. As an internet and handheld device-based English-language survey, it was limited to ICs with internet access and proficient in the English language. The overall response to the survey was 10.4%. This response rate is comparable to other contemporary interventional cardiology surveys.[15] Although the response rate was highest from the United States, Italy, and China, it could be an underestimate given the fact that operators most impacted by the pandemic may be less likely to participate in an online survey because of lack of time or overwhelming psychological stress. The 100% completion of the survey by those who started suggests that our survey had a user-friendly interface, was timely, and was meaningful to participants.

CONCLUSIONS

Our survey indicates significant reduction in invasive procedure volumes and concern for viral transmission among ICs. Although there is universal adoption of

personal protective equipment, COVID-19 pretesting and access to FIT-tested masks are suboptimal. Providers are concerned about impending financial losses but are also taking proactive steps to cope with this unprecedented crisis through substantially increased engagement in remote patient care and online education, as well as measures to reduce work to home transmission.

ARTICLE INFORMATION

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