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Specific Considerations for Pediatric, Fetal, and Congenital Heart Disease Patients and Echocardiography Service Providers during the 2019 Novel Coronavirus Outbreak: Council on Pediatric and Congenital Heart Disease Supplement to the Statement of the American Society of Echocardiography Endorsed by the Society of Pediatric Echocardiography and the Fetal Heart Society

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BACKGROUND

The American Society of Echocardiography has recently released a statement on the “Protection of Patients and Echocardiography Service Providers during the 2019 Novel Coronavirus Outbreak,” which will be continually updated as more data become available.¹ The pediatric and congenital heart disease (PCHD) population adds a confounding variable to this pandemic, which this supplement to the main statement¹ means to address. Readers are recommended to review the main statement; this supplement will discuss how the PCHD population is different from the adult population, including transmission risk and indications for echocardiography, variations in protocols, and recommendations for fetal echocardiography and transesophageal echocardiography (TEE) for the PCHD population.

Although children as an entire group appear to be at lower risk for severe disease compared with adults, certain ages are more susceptible to severe disease than others (particularly infants and preschool-age children and possibly premature infants).² The overall lower prevalence of severe disease paradoxically means that a large number of infected children may be asymptomatic or minimally symptomatic.^{2,3} When combined with the high viral loads present in nasopharyngeal and fecal secretions,^{4,5} frequency of other upper respiratory tract viral coinfections,³ necessity of adults accompanying children to medical

care, and limited capabilities to avoid droplet expression in infants and toddlers, echocardiographic scanning of children may create an increased risk of staff and community exposure. Consequently, PCHD echocardiography providers will be exposed to SARS-CoV-2, perhaps often unknowingly, requiring adjustments in practice to provide expert care and limit further community transmission.

Indications for the use of echocardiography in the PCHD population also differ from the adult population.⁶ For PCHD patients, echocardiography will remain critical for the assessment of children with suspected heart disease, management of children and young adults with acquired and congenital heart disease (CHD) at different stages of repair, palliation or transplant, and children at risk of functional heart disease (e.g., receiving chemotherapy) or cardiac complications from respiratory infection. Fetal echocardiography and TEE represent important clinical scenarios requiring variations in management. Pregnancies will continue, and fetal heart disease remains critical to diagnose and manage, albeit while reducing risk for infection of the mother or provider. Avoidance of provider transmission to the premature infant population with lung disease of different etiologies is similarly critical.

WHOM TO IMAGE?

Review of Indications

As a general principle, transthoracic echocardiography (TTE), stress echocardiograms, TEE, and fetal echocardiograms should only be performed if they are expected to provide clinical benefit. Decisions on whether or not an echocardiogram should be performed in a PCHD patient may be guided by the appropriate use criteria established by the American Society of Echocardiography and other societies,^{7,8} with risk of SARS-CoV-2 infection highlighting the need to avoid rarely appropriate exams. In addition, multiple societies (American Institute of Ultrasound in Medicine [AIUM], International Society of Ultrasound in Obstetrics and Gynecology [ISUOG], and American Heart Association [AHA]) have established guidelines for indications for fetal echocardiography referral. A full discussion of how to

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Abbreviations

AHA = American Heart Association
AIUM = American Institute of Ultrasound in Medicine
ASE = American Society of Echocardiography
CHD = Congenital heart disease
CVOR = Cardiovascular operating room
GA = Gestational age
ISUOG = International Society of Ultrasound in Obstetrics and Gynecology
MFM = Maternal-fetal medicine
MRI = Magnetic resonance imaging
PAPR = Powered air purifying respirators
PCHD = Pediatric and congenital heart disease
POCUS = Point-of-care ultrasound
PPE = Personal protective equipment
TEE = Transesophageal echocardiography
TTE = Transthoracic echocardiography

determine both *whom* should be imaged as well as *when* imaging should be considered is presented in the main statement,¹ acknowledging that adjustments to these decisions should be made by each individual institution.

Fetal echocardiographic evaluation presents different challenges; there is a finite gestational period within which pregnancy decision-making and perinatal/neonatal management plans are made. The AHA divides fetal echocardiography referrals into risk levels based on indication.⁹ Triage and scheduling of these patients in general can be determined based on an assessment of level of risk relating to the indication for referral as well as the fetal diagnosis. Transesophageal echocardiography carries a heightened risk of spread of SARS-CoV-2 since it can provoke aerosolization of a large amount of virus. Whether the intubated PCHD patient having a TEE exposes the care team to a greater risk with this modality compared with TTE remains unclear. Considerations for both fetal echocardiography and PCHD TEE are discussed in greater detail in the Advanced Imaging section below.

caution that it is always important for pregnant women to protect themselves from illnesses, although the current recommendation is for them to follow the same precautions as the general public to avoid infection. For fetal cardiology visits, a maximum of one support person who undergoes the same screening process as the patients may accompany the pregnant women to the visit; however, to minimize exposure, the echocardiogram scanning room should be limited to the pregnant woman alone and the sonographer. Counseling of the family should be limited to the pregnant woman and one support person at most, although if possible, having the support person be offsite and participate in the counseling session using telemedicine may be beneficial. Telemedicine consultation without fetal echocardiogram should be considered when the visit is limited to follow-up counseling of established fetal cardiovascular disease. If the fetal echocardiogram can be performed and then read remotely (e.g., for known CHD, SSA/SSB antibody, or arrhythmia follow-up), telemedicine should be considered for relaying findings and performing counseling. This may be particularly useful if the fetal echocardiogram can be done in the maternal-fetal medicine (MFM) office, where visits can be consolidated to include routine obstetrical care. Home fetal heart rate monitoring with telemedicine consultation instead of intermittent fetal echocardiography can also be considered in cases of fetal arrhythmia to minimize follow-up clinic visits.

HOW TO IMAGE?

Protocols

Infants or children presenting with known or suspected CHD, cardiomyopathy, or myocarditis may have intercurrent respiratory illnesses and thus may be under suspicion for SARS-CoV-2 infection. This will require modification of PCHD imaging protocols away from “complete” studies and toward more focused exams. However, the breadth of CHD and the challenges of systolic and diastolic function assessment in the PCHD population mean that unless the patient is in immediate need of assessment of only systolic function or pericardial effusion, “traditional” TTE by cardiology (pediatric or adult CHD) is preferred over point-of-care ultrasound (POCUS) in the pediatric emergency center or intensive care unit. If a POCUS exam is performed, images should be saved and archived in a manner that allows review and remote interpretive assistance from experienced pediatric echocardiographers as well as comparison of cardiac structure and function over time. Review of POCUS studies may also help focus future imaging studies.

Additional recommendations for focusing exams, particularly in patients with suspected or confirmed COVID-19, are presented in the main statement.¹ These include the use of live feeds and/or remote feedback to limit personnel in the patient room and matching of sonographer skill to study indications to maximize diagnostic accuracy while minimizing scan time. As for adult patients, scans should be reviewed and results recorded and communicated to the ordering team as quickly as possible to facilitate care.

For fetal echocardiographic studies, a complete study should be performed for all new consultations in order to minimize the need for repeat studies. Centers should have well-defined study protocols and checklists available as the study is being performed and as it is reviewed prior to the pregnant woman leaving the exam room. For follow-up scans deemed necessary, a focused study based on a predetermined checklist provided by the fetal cardiologist may be utilized. Prolonged scanning should be avoided. Transvaginal fetal echocardiographic studies should not be performed.

Where to Image?

The increased possibility that children may be infected with no or minimal symptoms may limit the utility of adult-focused screening measures. This may then necessitate adjustments to both inpatient and outpatient procedures such as designating which studies should be performed as portable studies or designation of specific echo lab scan rooms or outpatient clinic sites. Given the higher risk of asymptomatic transmission in children, some centers in endemic regions are also choosing to test all new pediatric admissions for SARS-CoV-2.

For institutions where fetal imaging occurs within the cardiology clinic, consideration should be given for pregnant women to be sequestered in a separate area from the pediatric patients, in both the waiting room and echo lab. Unlike previous viral outbreaks (H1N1, SARS-CoV, MERS-CoV), which were found to be associated with severe complications in pregnant women, currently the limited information available suggests that pregnant women are not more susceptible to SARS-CoV-2 infection or more prone to developing severe complications if infected.¹⁰ Given the uncertainty and possibility of increased risk as more data become available, the Centers for Disease Control and Prevention

Protection

Imaging of the pediatric patient with possible or confirmed COVID-19 differs from imaging of the adult in several ways. Children may frequently be asymptomatic or minimally symptomatic, which may unknowingly expose the provider to infection. Children are often unable to cooperate and follow instructions; cardiac anatomy may be highly variable and require longer scan times to assess; and sedation may be necessary for even routine transthoracic studies. Thus protection procedures require modification to those recommended for general adult echocardiography as presented in the main statement.¹ These PCHD modifications are presented below. Additional information regarding the role of learners, options for echocardiography education in the absence of direct scanning, and important general considerations for reducing transmission outside of the scan room are presented in the main statement.¹

Personnel

In the same way as for the adult patient, imaging should be performed according to local standards for the prevention of virus spread, including use of personal protective equipment (PPE). Meticulous and frequent hand washing is crucial and applies to the sonographer, patient when possible, and a single caregiver who is likely to make physical contact with the patient and sonographer while helping to facilitate the cooperation of an active child. A surgical face mask should be worn by symptomatic patients, provided appropriate pediatric and adult-sized masks are available and institutional resources allow this strategy for source control.¹¹ In addition to the aerosolized transmission of SARS-CoV-2, potential for fecal transmission has been reported.^{5,12} Diaper care should therefore be avoided if possible during the exam, and if necessary performed with appropriate virucidal hygiene.

The performance and interpretation of pediatric and fetal echocardiographic studies, especially those in suspected or confirmed COVID-19 cases, should be limited to essential personnel. Potentially complicated exams should be directed to experienced sonographers who are most likely to be able to perform an appropriately detailed, accurate, and expeditious exam without the need for additional hands-on support. In many institutions, PCHD fellows provide crucial off-hours scanning and interpretation, but their skill level should be matched to patient complexity with availability of additional imager expertise when an expeditious exam cannot be performed. In addition to limiting the number of echocardiography practitioners involved in scanning, consideration should be given to limiting the exposure of staff who may be particularly susceptible to severe complications of COVID-19. Staff who are >60 years old, have chronic conditions, are immunocompromised, or are pregnant may wish to avoid contact with patients suspected or confirmed to have COVID-19, depending on local procedures.

For intraoperative TEE, which is an essential contributor to the effective surgical treatment of CHD, strong consideration should be given to requesting that the anesthesiologist place the TEE probe immediately after airway intubation while using appropriate aerosol precautions. Probe removal should be performed while the patient is under deep general anesthesia while intubated, with the probe immediately cleaned and then placed in a transport container for disinfection. There should be at most one person to handle the probe and another to operate the machine controls, along with another to administer anesthesia or sedation. Many pediatric echocardiographers are capable of simultaneously manipulating the TEE probe and operating the machine; this practice should be encouraged to

reduce exposure of an additional provider, presuming skill with this technique and that use of this technique will not increase total scan time.

Equipment

Equipment care is critical in the prevention of SARS-CoV-2 transmission. Options to decrease fomite transmission may include covering probes and machine consoles with disposable plastic and foregoing the use of electrocardiogram stickers or setting aside certain machines or probes for use on patients with suspected or confirmed infection. Similarly, setting aside a separate machine for sole use in expected high-risk groups such as the neonatal intensive care unit is encouraged when possible. Equipment cleaning should be performed according to institutional and vendor guidelines. Additional guidelines for the disinfection of ultrasound equipment are available through the AIUM.¹³ Smaller, laptop-sized portable machines are more easily cleaned, but use of these machines should be balanced against potential trade-offs in image quality and functionality.

Advanced Imaging

Fetal Echocardiography. Fetal echocardiography and the care of pregnant women require a separate triaging system, which can be divided into three subgroups (Table 1 and Figure 1).

- Fetal echocardiogram for low-risk patients: if a detailed second trimester fetal anatomic scan including adequate cardiac screening views can be confirmed by combined experience of practitioners (fetal cardiologist with MFM specialist/obstetrician), no fetal echocardiographic evaluation is scheduled.
- Fetal echocardiogram for moderate-risk patients: delay fetal echocardiography evaluation to a later date when SARS-CoV-2 risk is decreased or after 28 weeks' gestation (or earlier in specific situations, described in more detail below).
- Fetal echocardiogram for high-risk patients or urgent clinical indications: schedule and perform promptly (although consider alternatives such as lowest risk facility for imaging and telemedicine for consultation to minimize risk).

This triage system requires close communication with the referring obstetrical and MFM teams, noting that the recommended algorithms presented are not evidence based but do represent shared perceived best practices and can be modified by each institution to best match local resources. Once it is decided that a fetal cardiology visit is needed, the timing of the fetal cardiology visit is based on multiple factors: (1) the risk profile of the indication (see Table 1); (2) the adequacy of the anatomy scan with cardiac views (determined by local collaborative experience of the referring doctor and fetal cardiologist, or if needed, direct review of the cardiac screen, or discussion with the referring doctor); (3) the gestational age (GA) of the fetus, which influences both pregnancy decision-making and the need for additional testing (e.g., amniocentesis, ultrasound, magnetic resonance imaging [MRI], GA < 24 weeks), and delivery planning for fetal CHD (GA ≥ 34 weeks). For those deferred to a later date, creation of a virtual "waiting list" should be considered for scheduling to assure that all patients at risk are evaluated prior to delivery. Fetal cardiovascular diseases requiring transplacental therapy (e.g., fetal tachyarrhythmia or autoimmune-mediated evolving congenital heart block) should be considered urgent indications for echocardiography and consultation, and scheduling and evaluating these patients should follow the admitting institutions' COVID-19 policies for urgent admissions. Performance of fetal cardiac interventions (i.e., balloon aortic or

Table 1 Fetal cardiology clinic scheduling structure during COVID-19 outbreak

Category	Definition	Action	Examples
Low risk	<ul style="list-style-type: none"> • Low-risk referral indication • Fetal anatomy scan: normal cardiac screening exam (verified by combined experience of practitioners, or if needed by discussion with MFM or image review) 	<ul style="list-style-type: none"> • Cancel or do not schedule 	<ul style="list-style-type: none"> • In vitro fertilization • Gestational diabetes • Family history of CHD (excluding exceptions noted below) • Medication exposure • Single umbilical artery • Dichorionic twins (without additional concerns)
Moderate risk	<ul style="list-style-type: none"> • Moderate-/high-risk referral indications when GA \geq 24 weeks • Confirmed CHD when GA < 34 weeks 	<ul style="list-style-type: none"> • Reschedule or schedule after COVID-19 risk is decreased or GA \geq 28 weeks (consider creating a virtual “waiting list” to track patients) 	<ul style="list-style-type: none"> • Second opinion for CHD already identified; may schedule, consider telemedicine review of images and counseling • Fetal anatomy scan cannot confirm normal cardiac structures; may schedule but consider telemedicine review of images and counseling if needed • Pregestational diabetes with HgbA1C \geq 8, increased Nuchal Translucency \geq 3.5, or CHD with increased recurrence in first-degree relative (e.g., left-sided obstructive lesion, heterotaxy, maternal atrioventricular septal defect)
High risk	<ul style="list-style-type: none"> • Urgent clinical indication • Moderate-/high-risk referral indication when GA < 24 weeks • Confirmed CHD when GA \geq 34 weeks 	<ul style="list-style-type: none"> • Schedule next available 	<ul style="list-style-type: none"> • Suspected CHD (any GA) • Known CHD at risk for compromise or rapid progression • Final visit for delivery planning for known CHD or second opinion for CHD • Genetic/extracardiac anomaly with need to assess heart • Fetal arrhythmia (excluding isolated premature atrial contractions), new and follow-up as indicated • SSA/SSB-positive mother; new visit (provide fetal heart rate home monitor if available; follow-up at GA of 20 and 26 weeks) • Fetal anatomy scan does not confirm normal cardiac structures • New monochorionic-diamniotic twin pregnancy, particularly with concern for twin-twin transfusion syndrome • Pregestational diabetes with HgbA1C \geq 8, increased NT \geq 3.5, or CHD with increased recurrence in first-degree relative (e.g., left-sided obstructive lesion, heterotaxy, maternal atrioventricular septal defect) • Maternal anxiety not ameliorated with telemedicine consultation

(Continued)

Table 1 (Continued)

Category	Definition	Action	Examples
Telemedicine	<ul style="list-style-type: none"> • Remote image review • Ongoing follow-up care in collaboration with MFM • Counseling 	<ul style="list-style-type: none"> • Perform as needed 	<ul style="list-style-type: none"> • Review of cardiac screening exams or fetal echocardiograms done offsite • Second opinion for CHD already identified with complete fetal echocardiogram available for review • Interval follow-up counseling for known CHD until ≥ 34 weeks • Counseling sessions with maternal family/support off site

pulmonary valvuloplasty, atrial septal stenting) remains at the discretion of the institution, although given the current body of evidence on risk-benefit ratio, delaying or not doing the procedure may be considered. The timing and performance of fetal interventions for twin-twin transfusion syndrome are beyond the scope of this document.

The possibility of prenatal or perinatal infection should be considered when neonates are transferred to the neonatal or pediatric cardiac intensive care unit following delivery. There are inconclusive data regarding vertical transmission of SARS-CoV-2; however, if a pregnant woman tests positive for the virus within 14 days of delivery,

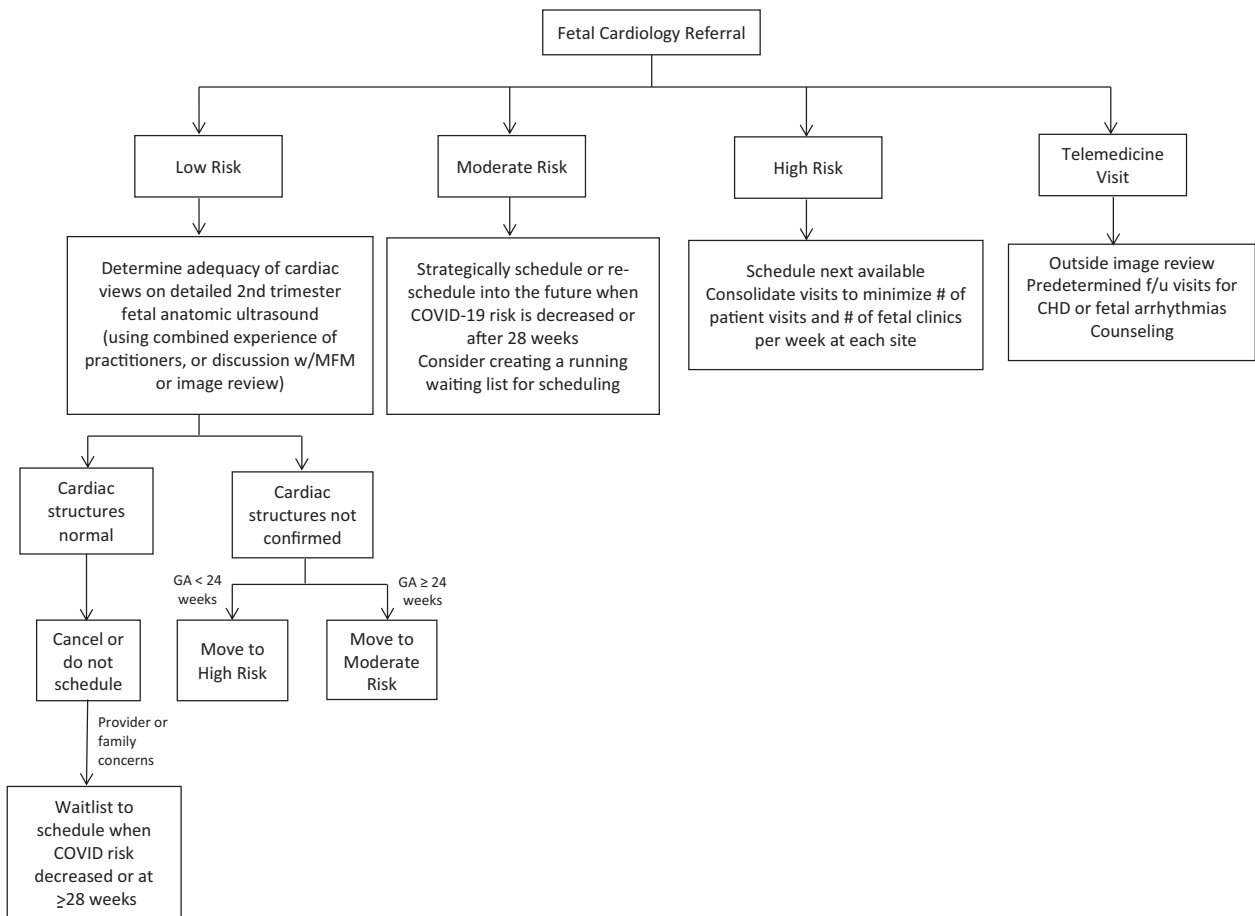


Figure 1 Fetal cardiology clinic scheduling algorithm during COVID-19 outbreak.

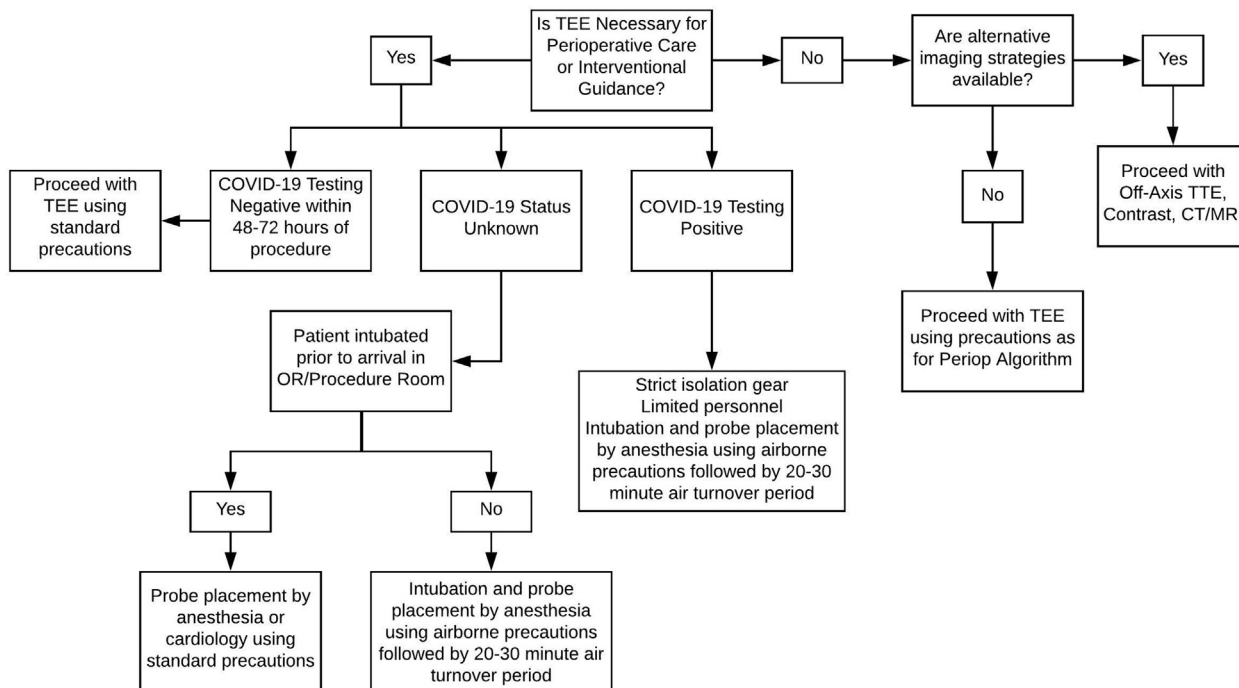


Figure 2 Suggested algorithm for performing TEE during COVID-19 outbreak.

the newborn should be tested and treated as positive, with use of appropriate PPE, until a negative result is confirmed.

Transesophageal Echocardiography. Transesophageal echocardiography carries a heightened risk of spread of SARS-CoV-2 since aerosolization of virus may be provoked during the procedure. This is of particular concern if the TEE is performed without concomitant endotracheal intubation, due to the coughing or gagging that may accompany probe placement and manipulation. However, aerosolization and provider exposure may be possible even with an endotracheal tube in place due to the instrumentation and manipulation of the oropharynx that occurs with TEE probe placement. Therefore, TEEs deserve special consideration in determining when and whether they should be performed and with what precautions; TEE should be considered an integral part of PCHD perioperative care or care during PCHD cardiac catheter interventions. Outside of these scenarios, TEE should be considered a high-risk procedure and the benefits of a TEE examination should be weighed against the risk of exposure of health care personnel in a patient with suspected or confirmed COVID-19 and the availability of PPE. Transesophageal echocardiograms should be postponed or canceled if an alternative imaging modality (e.g., off-axis TTE views, agitated saline contrast, or other ultrasound-enhancing agent with TTE) can provide the necessary information. Contrast enhanced computed tomography and MRI may also be considered as alternatives to TEE. The benefits of avoiding an aerosolizing procedure should be balanced against the risk of transport, need to disinfect a different scan room, and baseline risks in children of iodinated contrast and radiation with computed tomography and longer scan times for MRI.

Given the unreliability of symptoms to predict COVID-19 status in children, use of a standardized algorithm for TEE procedures is recommended. An example is presented below and in [Figure 2](#). Modification and implementation of any TEE algorithm should be coordinated with all members of the perioperative team at each institu-

tion to best match resources and equipment. Ideally, as SARS-CoV-2 testing becomes more available at the hospital level with more rapid results, all patients for whom TEE is planned (i.e., most surgical patients and some interventional cardiac catheterization patients) should have SARS-CoV-2 testing performed during preop screening.

1. All pediatric patients for TEE are presumed positive unless they have had a negative COVID-19 test within 48-72 hours. **If documented negative COVID-19 testing, then TEE may proceed using standard precautions (gloves, mask, and eye protection).**
2. For **pediatric patients without COVID-19 negative testing within 72 hours who are intubated prior to arrival to the cardiovascular operating room (CVOR)/interventional suite**, the risk for aerosolization is considered low. Probe placement may be performed by anesthesia to minimize personnel performing oropharyngeal manipulation or by cardiology according to institutional standard procedures and following standard precautions.
3. For **asymptomatic patients without COVID-19 negative testing within 72 hours who require intubation in the CVOR/interventional suite**, anesthesia should intubate donning appropriate PPE/powered air purifying respirators (PAPRs). This should be followed by a wait period (typically 20-30 minutes depending on local protocols and environmental factors) to permit complete air turnover in the room, during which no one should enter. Strong consideration should be given to TEE probe placement by anesthesia immediately following airway stabilization while still under aerosol precautions and prior to the air turnover period to minimize the risk of exposure of additional personnel. After the wait period, probe manipulation may be performed by cardiology according to institutional standard procedures and following standard precautions.
4. For **COVID-19 positive or symptomatic children without COVID-19 negative testing within 72 hours**, strict isolation is mandated. Strong consideration should be given to probe placement by anesthesia to minimize risk of exposure associated with oropharyngeal manipulation and according to institutional standard procedures.
 - a. All personnel in the CVOR, interventional suite, or procedure room must wear strict isolation gear at all times.
 - b. All personnel must have training in donning and doffing PPE/PAPR.

- Defer/Reschedule Options
 - Identify and defer all elective exams
 - Identify and perform only urgent/emergency exams
 - Assess need for fetal echocardiogram and schedule using algorithm
- Assess patient COVID-19 status
 - Negative
 - Suspected
 - Unknown (for TEE, treat as suspected)
 - Positive/confirmed
- Provide for appropriate levels of patient and provider protection
- TEEs are considered high risk
 - Defer or use alternative imaging strategies if possible
 - Perform SARS-CoV-2 testing at preoperative visit, if possible
 - Proceed with TEE using precautions based on algorithm
- Institutional PPE conservation
 - Defer non-urgent exams in suspected/confirmed cases
- Limit exposure during exams
 - Problem-focused, limited examinations guided by prior studies
 - Match personnel skills to exam to minimize scan time
 - Consider use of dedicated machine for suspected/confirmed cases or high-risk units
 - Minimize both respiratory and fecal exposure during exam
- Reading room methods to reduce transmission
 - Facilitate remote report generation and echo consultation
 - Frequent disinfection of computer keyboard, mouse, surfaces, chairs, doorknobs
 - Discourage congregating in the echo lab reading room
- Identify and appropriately reassign special at-risk personnel (>60 years, chronic illness, immunocompromised, pregnancy, etc.)

Figure 3 Summary of recommendations for policies/procedures during COVID-19 outbreak.

- c. Only essential personnel are allowed in CVOR to preserve PPE and mitigate exposure risk (one echo person only).

CONCLUSION

The provision of echocardiographic services to the PCHD population remains crucial during this SARS-CoV-2 outbreak. Differences between the adult and PCHD populations require modifications to prior practices. These PCHD modifications are summarized in [Figure 3](#). Working together with our adult cardiology, anesthesia, MFM, and pediatric colleagues, we can continue to provide high-quality care while minimizing risk to ourselves, our patients, and the public.

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NOTICE AND DISCLAIMER: This statement reflects recommendations based on expert opinion, national guidelines, and available evidence. Our knowledge with regard to COVID-19 continues to evolve, as do our institutional protocols for dealing with invasive and noninvasive procedures and practice of personal protective equipment. Readers are urged to follow national guidelines and their institutional recommendations regarding best practices to protect their patients and themselves. These reports are made available by the American Society of Echocardiography (ASE) as a courtesy reference source for its members. The reports contain recommendations only and should not be used as the sole basis to make medical practice decisions or for disciplinary action against any employee. The statements and recommendations contained in these reports are primarily based on the opinions of experts, rather than on scientifically verified data. The ASE makes no express or implied warranties regarding the completeness or accuracy of the information in these reports, including the warranty of merchantability or fitness for a particular purpose. In no event shall ASE be liable to you, your patients, or

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REFERENCES

1. Kirkpatrick JN, Mitchell C, Taub C, Kort S, Hung J, Swaminathan M. ASE statement on protection of patients and echocardiography service providers during the 2019 novel coronavirus outbreak. *J Am Soc Echocardiogr* 2020;33:648-53.
2. Dong Y, Mo X, Hu Y, Qi X, Jiang F, Tong S. Epidemiological characteristics of 2143 pediatric patients with 2019 coronavirus disease in China. *Pediatrics* 2020; <https://doi.org/10.1542/peds.2020-0702>.
3. Cruz A, Zeichner S. COVID-19 in children: initial characterization of the pediatric disease. *Pediatrics* 2020; <https://doi.org/10.1542/peds.2020-0834>.
4. Wölfel R, Corman V, Guggemos W, Seilmaier M, Zange S, Mueller M, et al. Clinical presentation and virological assessment of hospitalized cases of coronavirus disease 2019 in a travel-associated transmission cluster. *MedRxiv* 2020; <https://doi.org/10.1101/2020.03.05.20030502>.
5. Xiao F, Tang M, Zheng X, Liu Y, Li X, Shan H. Evidence for gastrointestinal infection of SARS-CoV-2. *Gastroenterology* 2020; <https://doi.org/10.1053/j.gastro.2020.02.055>.
6. Zheng YY, Ma YT, Zhang JY, Xie X. COVID-19 and the cardiovascular system. *Nat Rev Cardiol* 2020; <https://doi.org/10.1038/s41569-020-0360-5>.
7. Campbell RM, Douglas PS, Eidem BW, Lai WW, Lopez L, Sachdeva R. ACC/AAP/AHA/ASE/HRS/SCAI/SCCT/SCMR/SOPE 2014 appropriate use criteria for initial transthoracic echocardiography in outpatient pediatric cardiology: a report of the American College of Cardiology Appropriate Use Criteria Task Force, American Academy of Pediatrics, American Heart Association, American Society of Echocardiography, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Pediatric Echocardiography. *J Am Soc Echocardiogr* 2014;27:1247-66.
8. Sachdeva R, Valente AM, Armstrong AK, Cook SC, Han BK, Lopez L, et al. ACC/AHA/ASE/HRS/ISACHD/SCAI/SCCT/SCMR/SOPE 2020 appropriate use criteria for multimodality imaging during the follow-up care of patients with congenital heart disease: a report of the American College of Cardiology Solution Set Oversight Committee and Appropriate Use Criteria Task Force, American Heart Association, American Society of Echocardiography, Heart Rhythm Society, International Society for Adult Congenital Heart Disease, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Pediatric Echocardiography. *J Am Coll Cardiol* 2020;75:657-703.
9. Donofrio MT, Moon-Grady AJ, Hornberger LK, Copel JA, Sklansky MS, Abuhamad A, et al. Diagnosis and treatment of fetal cardiac disease: a scientific statement from the American Heart Association. *Circulation* 2014;129:2183-242.
10. Poon LC, Yang H, Lee JCS, Copel JA, Leung TY, Zhang Y, et al. ISUOG Interim Guidance on 2019 novel coronavirus infection during pregnancy and puerperium: Information for healthcare professionals. *Ultrasound Obstet Gynecol* 2020; <https://doi.org/10.1002/uog.22013>.
11. Centers for Disease Control and Prevention. Strategies for optimizing the supply of facemasks. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/face-masks.html>. Accessed March 20, 2020.
12. Gu J, Han B, Wang J. COVID-19: gastrointestinal manifestations and potential fecal-oral transmission. *Gastroenterology* 2020; <https://doi.org/10.1053/j.gastro.2020.02.054>.
13. AIUM. Guidelines for cleaning and preparing external- and internal-use ultrasound transducers between patients and safe handling and use of ultrasound coupling gel. Available at: <https://www.aium.org/officialStatements/57>. Accessed March 28, 2020.

RESOURCES

1. ASE COVID-19 resource page, <https://www.asecho.org/covid-19-resources/>.
2. Connect@ASE COVID-19 discussion page, [https://connect.asecho.org/groups/534-Coronavirus-\(COVID-19\)](https://connect.asecho.org/groups/534-Coronavirus-(COVID-19)).
3. American Institute for Ultrasound in Medicine (AIUM) guidelines for equipment disinfection, <https://www.aium.org/officialStatements/57>.
4. Centers for Disease Control COVID-19 resource page, <https://www.cdc.gov/coronavirus/2019-nCoV/index.html>.
5. Centers for Disease Control recommendations for infection prevention and control, <https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html>.
6. Centers for Disease Control visual guide for using personal protective equipment, <https://www.cdc.gov/hai/pdfs/ppe/PPE-Sequence.pdf>.
7. ISUOG Safety Committee Position Statement: safe performance of obstetric and gynecological scans and equipment cleaning in the context of COVID-19, <https://www.isuog.org/resource/isuog-safety-committee-position-statement-safe-performance-of-obstetric-and-gynecological-scans-and-equipment-cleaning-in-the-context-of-covid-19.html>.
8. The Society for Maternal Fetal Medicine COVID-19 Ultrasound Practice Suggestions, [https://s3.amazonaws.com/cdn.smfm.org/media/2272/Ultrasound_Covid19_Suggestions_\(final\)_03-24-20_\(2\)_PDF.pdf](https://s3.amazonaws.com/cdn.smfm.org/media/2272/Ultrasound_Covid19_Suggestions_(final)_03-24-20_(2)_PDF.pdf).