



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

# Journal Pre-proof

Echocardiography in the Time of COVID-19

Michael H. Picard, MD, FASE, Rory B. Weiner, MD, FASE

PII: S0894-7317(20)30222-4

DOI: <https://doi.org/10.1016/j.echo.2020.04.011>

Reference: YMJE 4472

To appear in: *Journal of the American Society of Echocardiography*

Received Date: 6 April 2020

Accepted Date: 6 April 2020

Please cite this article as: Picard MH, Weiner RB, Echocardiography in the Time of COVID-19, *Journal of the American Society of Echocardiography* (2020), doi: <https://doi.org/10.1016/j.echo.2020.04.011>.

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Copyright 2020 by the American Society of Echocardiography.



Echocardiography in the Time of COVID-19

Michael H. Picard, MD, FASE

Rory B. Weiner, MD, FASE

Corresponding author

Michael H. Picard, MD, FASE

Yawkey 5E

Massachusetts General Hospital

Harvard Medical School

Boston, MA 02114

mhpicard@mgh.harvard.edu

Keywords: COVID-19, echocardiography, coronavirus, heart disease

In this issue of the Journal of the American Society of Echocardiography there are three papers that discuss the impact of the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) on echocardiography laboratories and echocardiography service providers. The coronavirus disease-2019 (COVID-19) pandemic has resulted in multidimensional strain on the health care system, and while each of these papers includes authors from different “hot spots” around the world and evaluates issues from different perspectives, common themes emerge. The COVID-19 pandemic is forcing health care systems and societies to scrutinize how care is delivered, and valuable lessons are being learned, many of which will provide lasting insights past the time when the worst of this pandemic is behind us.

From Wuhan, China three cases are presented that illustrate not only the complex spectrum of cardiovascular disease associated with this coronavirus but also different ways in which cardiovascular ultrasound can be delivered (1). We are still learning the many ways that this virus impacts the heart. Cardiac failure has been noted to occur in a significant number of hospitalized, infected patients. There is the potential for cardiomyopathy due to direct effects of the virus, also as a result of the toxic effects of the cytokines that are released during the infection and even stress cardiomyopathy (i.e., Takotsubo Cardiomyopathy) has been noted. In many, a prothrombotic state or coagulopathy is induced which can lead to pulmonary emboli, intracardiac thrombus and exacerbation of coronary artery disease. The data show that those with preexisting cardiovascular disease are at highest risk for complications which suggests that in addition to the mechanisms described above, the stress of infection can transform a heart failure or coronary artery disease patient from a compensated state quickly to an unstable state (2). For example, the hypoxemia from acute respiratory distress syndrome will exacerbate the pre-existing cardiac disease. In the cases presented by Zhang and colleagues, it is likely that some or all of these patients had pre-existing cardiac disease based on features noted on the echocardiographic assessments of cardiac structure and function.

Regardless of whether the viral infection exacerbates pre-existing heart disease or causes new cardiac abnormalities these cases can serve as a platform to consider many issues. We know that chest pain is a common occurrence in this infection. We are also learning that biomarkers of cardiac injury are elevated in many of the infected, critically ill patients (3). While in other circumstance either one of these might trigger the request for a transthoracic echocardiogram (TTE), now we need to insure that performing the TTE will truly provide information not obvious on clinical assessment and that the results will assist in important treatment decisions. Thus, a pragmatic and practical approach is in order. While the echocardiogram might be of assistance, we need to ask if the use of limited personal protective equipment (PPE) and the exposure of additional personnel is justified. We also need to recognize that providing imaging services for this high-risk population will differ from our typical model. We should encourage focused exams to limit exposure time of the imager and also utilize cardiac point of care ultrasound (POCUS) by the clinical personnel who might already be in the room with these patients (thus conserving PPE).

Similar to the Chinese experience, our colleagues from Italy tell us of important roles for echocardiography in managing the critically ill patient (4). In addition, they highlight the role of lung ultrasound which may streamline the assessment of pulmonary involvement in the COVID-19 patient. While lung ultrasound has previously been part of the skill set for the critical care physician who performs POCUS, the opportunity and need now arises for sonographers and echocardiographers to rapidly learn this skill. In addition, we should consider this an opportunity to work with intensivists to enhance their cardiac imaging skills (5). Again, while cardiac and lung imaging can be performed in

many of these patients, it should be reserved for the patients in whom the immediate information from the echocardiogram is needed and has the potential to result in life-saving treatments.

The opinion piece by Drake and colleagues provides much information unrelated to cardiac imaging but since cardiologists are being called to take on front line clinical care responsibilities unrelated to cardiac imaging, this information will be helpful to our echocardiography community. Such topics include how a public health crisis is defined and the processes for dealing with limited resources (both personnel and equipment). The authors provide thoughtful guidance on how the move toward surge capacity of each hospital will affect practitioners and echocardiography labs. It is likely that few of us have in the past had to consider the implications of triaging patients and limited equipment during a public health crisis. A grim but realistic picture is painted by the authors as the focus shifts from optimizing care for each patient to a population-wide approach. While it is hoped that the “crisis standards of care” guidelines will not be needed, it is best that we all think about these issues in advance. Many facilities have clear crisis triage plans based on thoughtful ethical discussions, prior experiences (such as the 9/11 and Boston Marathon attacks) and disaster preparedness drills. It is our obligation to make sure our hospitals are prepared and everyone understands how and why such difficult decisions are made. Perhaps if the public understands that typical medical options might not be available for all then they will also clearly understand the importance of current efforts to slow the pandemic by “flattening the curve”. The paper by Drake et al also importantly stresses that decisions regarding allocation of limited resources should be made by committees composed of appropriate personnel and not by the people directly caring for the patient. Many such committees have been formed in hospitals across the United States.

While Drake et al remind us of the ethical principles and duties to treat all patients in the current pandemic, the ethical framework is complex. In addition to beneficence or doing good, the ethical framework includes nonmaleficence or avoiding harm (6). In this current situation we must all recognize that it is important not only to avoid harm to the patient but it is critical to carefully practice the necessary procedures to avoid spreading infection that could harm ourselves or others.

From the paper by Ward and colleagues we see the impact that COVID-19 has had on echocardiography ordering, screening and performance at the University of Chicago (7). This analysis of utilization and appropriateness of TTE provides many important insights. First, from an echocardiography laboratory operations standpoint, it is notable that with hospital and state directives to defer elective procedures, the weekly volume of TTE has been markedly decreased (84% among outpatient studies in this report). This is similar to the experience at our institution, with the primary goal to help protect patients and hospital staff by minimizing non-essential travel and practicing rigorous social distancing. What impact deferring these studies will have on future patient outcomes is not clear. From a practical standpoint how busy echocardiography laboratories will ultimately reschedule these studies for patients remains to be seen. The pandemic has provided an unexpected opportunity for clinicians and procedural labs to focus on which studies are truly needed. Appropriate Use Criteria for echocardiography have been in existence for over a decade (8) and the subject of much clinical investigation, although integration into routine clinical practice has been varied. The COVID-19 pandemic mandated a change in workflow, and the University of Chicago authors instituted a protocol which involves physician review of all echocardiography referrals. This essentially eliminated “rarely appropriate” TTEs (down to 1%). While many echocardiography labs have physician or other clinician review of transesophageal echocardiograms (TEE), the volume of TTE has been a barrier for doing so for that modality. This paper shows that when given no choice, it can be done and improves patient selection for TTE. The

sustainability of such a protocol after the pandemic is an obvious question, yet the principle that improved screening of ordered TTEs reduces inappropriate studies is a valuable lesson to carry forward.

Ward and colleagues also focus on the risks and benefits of performing TTE in the midst of the pandemic, which was also highlighted in the other papers. Specifically, the main risk considered is to the sonographers (or physicians) performing TTE, as the procedure requires prolonged and close contact with patients. Sonographer workplace safety has previously focused on areas such as radiation safety and ergonomic issues related to the nature of the work, although the COVID-19 situation has rightfully brought a new dimension to this discussion. The authors examined an alternative imaging protocol (limited TTE), which reduces imaging time and minimizes high risk exposure, and showed a significant increase in the use of limited TTE during the pandemic.

There are many take home points from these papers that highlight the world-wide reach of echocardiography, especially in the COVID-19 pandemic. This crisis has ironically forced us all to bring existing quality improvement initiatives to the forefront. Almost overnight, Cardiology Divisions have needed to enact new protocols to help strike a balance of optimal patient care, clinical workforce safety, and societal responsibility. Deferring echocardiography studies deemed non-urgent (or inappropriate) has greatly reduced volumes in an effort to protect patients and echocardiography laboratory staff. For the studies that should and must be done, evaluating limited imaging protocols and other modalities (POCUS) are well underway. This will provide an opportunity for needed real world study. Prior to the pandemic, there has been growing use of POCUS and guidelines written on its use (5). The use of smaller ultrasound machines including hand-held devices have been deployed in this new work-flow model and it will be interesting whether such implementation sticks. Some have raised concerns that



lack of uniform reporting and image storage for later review may be limiting factors to optimal adoption of this technology. We owe it to the patients being cared for during the pandemic, and to future patients, to rigorously evaluate the rapidly escalating incorporation of these technologies into clinical care. In an analogous fashion in clinical cardiology care, the use of virtual (video or telephone) visits is increasing rapidly by necessity and represents an area that can be studied to help guide optimal utilization in post-pandemic times.

The COVID-19 pandemic has forced echocardiography and cardiovascular practitioners, and all medical personnel for that matter, to critically evaluate clinical workflows and how care is delivered. A potential silver lining to our current situation, if there is one, is that cardiac imaging and cardiac clinical care is being streamlined with a renewed focus on appropriate use and performing imaging and other procedures that truly stand to benefit patients. These are valuable lessons that in some form should be carried forward when the COVID-19 pandemic is behind us, and perhaps we can emerge as a more efficient and patient-centered health care system that will prepare us for any future challenges that may arise. In conclusion, the model of how we provide echocardiography and to whom may be permanently modified by this current experience, and improved as we move forward.

## References

1. Zhang L, Wang B, Zhou J, Kirkpatrick J, Xie M, Johri AM. Bedside Focused Cardiac Ultrasound in COVID-19 Infection From the Wuhan Epicenter: The Role of Cardiac Point of Care Ultrasound (POCUS), Limited Transthoracic Echocardiography and Critical Care Echocardiography. *J Am Soc Echocardiogr* 2020;33:xxx-yyy
2. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *The Lancet*. March 11, 2020. doi: 10.1016/S0140-6736(20)30566-3. [epub ahead of print]
3. Shi S, Qin M, Shen B, Cai Y, Liu T, Yang F, et al. Association of Cardiac Injury With Mortality in Hospitalized Patients With COVID-19 in Wuhan, China. *JAMA Cardiology*. 2020. doi:10.1001/jamacardio.2020.0950
4. Drake DH, DeBonis M, Covella M, Agricola E, Zangrillo A, Zimmerman KG, et al. Echo in Pandemic: Front Line Perspective, Expanding Role of Ultrasound and Ethics of Resource Allocation. *J Am Soc Echocardiogr* 2020;33:xxx-yyy
5. Kirkpatrick JN, Grimm R, Johri AM, Kimura BJ, Kort S, Labovitz AJ, et al. Recommendations for Echocardiography Laboratories Participating in Cardiac Point of Care Cardiac Ultrasound (POCUS) and

Critical Echocardiography Training: A Report from the American Society of Echocardiography. J Am Soc Echocardiogr 2020;33:409-422

6. Kirkpatrick JN, Pearlman AS. Ethical Challenges in the Practice of Echocardiography: What is Right and How Do We Do It. J Am Soc Echocardiogr 2019;32:233-237.

7. Ward RP, Lee L, Ward TJ, Lang RM. Utilization and Appropriateness of Transthoracic Echocardiography In Response to the COVID-19 Pandemic. J Am Soc Echocardiogr 2020;33:xxx-yyy

8. Douglas PS, Garcia MJ, Haines DE, Lai WW, Manning WJ, Patel AR, et al. ACCF/AHA/ASA/ASNC/HFSA/HRS/SACI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. J Am Coll Cardiol 2011; 57:1126-66