

# Echocardiography during the coronavirus disease 2019 pandemic — the impact of the vaccination program. A 2021 update of the expert opinion of the Working Group on Echocardiography of the Polish Cardiac Society

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## A B S T R A C T

The coronavirus disease 2019 (COVID-19) pandemic resulted in an urgent need to reorganize the work of echocardiography laboratories in order to ensure the safety of patients and the protection of physicians, technicians, and other staff members. In the previous Expert Opinion of the Working Group on Echocardiography of Polish Cardiac Society we provided recommendations for the echocardiographic services, in order to ensure maximum possible safety and efficiency of imagers facing epidemic threat. Now, with much better knowledge and larger experience in treating COVID-19 patients and with introduction of vaccination programs, we present updated recommendations for performing transthoracic and transesophageal examinations, including information on the potential impact of personnel and the patient vaccination program, and growing numbers of convalescents on performance of echocardiographic laboratories, with the goal of their ultimate reopening.

**Key words:** COVID-19, echocardiography, echocardiographic laboratories, vaccination

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## INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic resulted in an urgent need to reorganize the work of echocardiography laboratories in order to ensure the safety of patients and protection of physicians, technicians, and other staff members. In the previous Expert Opinion of the Working Group on Echocardiography of Polish Cardiac Society we provided recommendations for the echocardiographic services, in order to ensure maximum possible safety and efficiency of imagers facing epidemic threat [1].

Restrictions imposed on transthoracic (TTE) and transesophageal (TEE) examinations due to the pandemic resulted in significant limitation of access of patients with cardiovascular diseases to services. Currently, a year after the initial document, there is a need to provide updated information on the current knowledge on the COVID-19 pandemic as well as, perhaps even more importantly, on the potential impact of the vaccination program and growing numbers of convalescents on everyday practice of echocardiographic laboratories. Moreover, with much better knowledge and larger experience in treating COVID-19 patients, and with the introduction of vaccination programs, recommendations for TTE or TEE adopted for epidemic conditions, and health requirements need to be updated. This update is especially appropriate now when a substantial proportion of medical personnel in Poland are vaccinated with two doses of a mRNA vaccine and when, despite the current peak of the pandemic, we must think about the goal of restoring full capacity of echocardiographic laboratories, once the pandemic is under control [2].

For the purpose of this document we define the latter as the low and decreasing number of cases; the number of positive tests/number of all tests below 5%; contact tracing system is active and fully operational; at least 70% of personnel and general adult population are vaccinated; no new viral strains escaping from acquired immunity are detected.

Importantly, while certain regulators accept fully vaccinated people gathering indoors without wearing masks, we propose that until the end of the pandemic also vaccinated personnel and patients should wear masks during echocardiographic examinations, both in the in-patient and out-patient settings [3]. This recommendation may change as knowledge about the efficacy of vaccination programs expands.

## COVID-19 AND CARDIOVASCULAR DISEASE

The COVID-19 pandemic has numerous cardiovascular implications. Firstly, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) may adversely affect the cardiovascular system of infected patients. The proposed underlying pathophysiological mechanisms include hypoxemia, systemic inflammatory response, hypercoagulability, sympathetic stimulation, direct myocardial and vascular infection and myocyte necrosis. Myocardial injury detected by elevated cardiac biomarkers has been observed in 5%

to 38% of hospitalized patients, depending on the criteria used. The most frequently described clinical manifestations of cardiovascular involvement include thromboembolism, arrhythmia, myocarditis, acute coronary syndrome, stress cardiomyopathy and heart failure, but the autopsy data suggest that their incidence may be underestimated [4, 5].

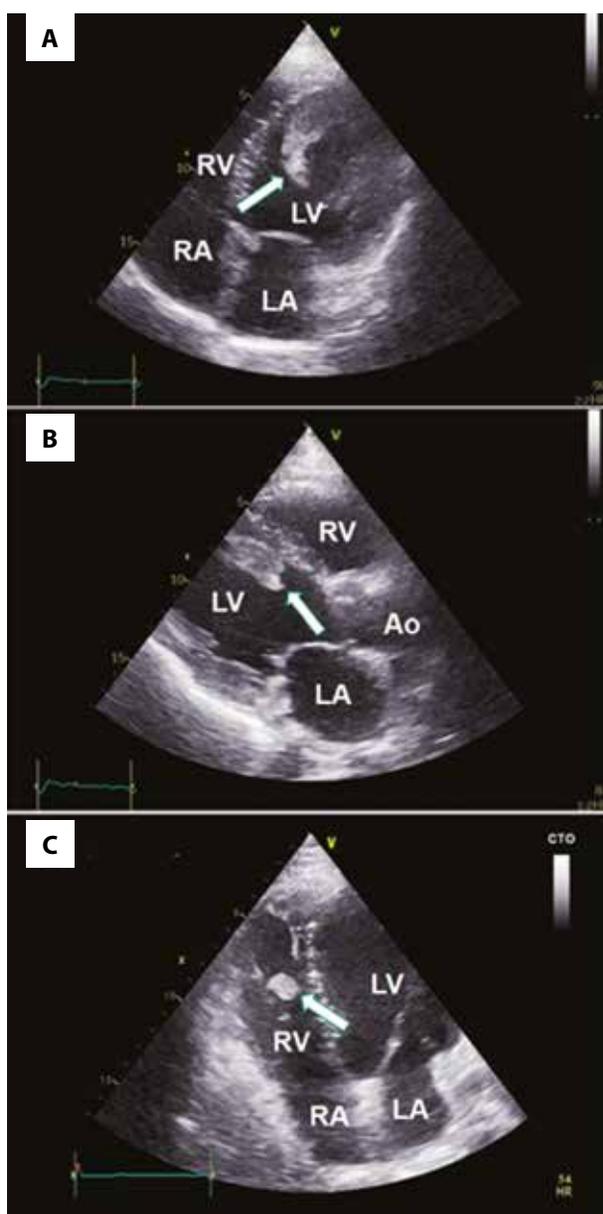
Secondly, one should consider adverse cardiovascular effects of drugs prescribed to treat SARS-CoV-2 and post-viral complications, such as pediatric inflammatory multisystem syndrome. Thirdly, pre-existing cardiovascular diseases are the most common comorbidities in infected patients, with hypertension being the most common one. Of note, both cardiac involvement during SARS-CoV-2 infection and preexisting cardiovascular disorders have been shown to be associated with more severe clinical course of COVID-19 and worse prognosis [6].

## ACUTE AND LONG-TERM ECHOCARDIOGRAPHIC FINDINGS IN COVID-19 PATIENTS

COVID-19 is a primarily respiratory infection, with common cardiovascular involvement in severe and critical stages of the disease. Echocardiography represents a versatile diagnostic procedure requiring high level of physician-patient interaction, thus posing a risk for infection. This is especially true for transesophageal studies (also most of stress-echo protocols) which are highly aerosol-generating. The policies of use of TTE in COVID-19 healthcare facilities may vary, but the general indication depends on potential impact of findings upon the management of the patient. Both the evidence of cardiovascular involvement during COVID-19 and precise identification of preexisting cardiovascular conditions may contribute to proper management.

Cardiac dysfunction present prior to the SARS-CoV-2 infection can influence the findings, the clinical course of the infection and the prognosis. Therefore, prior to interpretation of the echocardiographic study, an attempt should be made to determine the preexisting cardiac pathology based on the history and available medical records. Symptoms reported during COVID-19 are nonspecific and can result from other organ damage (i.e., lungs, skeletal muscles, kidneys, nervous system, etc.) or from psychological reasons and stress. Therefore, TTE is crucial to detect and differentiate the cardiac and non-cardiac reasons.

The most important cardiac complications of COVID-19 are myocardial injury and cardiovascular thrombosis [7–9]. Myocardial damage is more frequently found in patients with abnormal electrocardiogram or elevated biomarkers (troponin or natriuretic peptides) and these patients should undergo TTE. It is probably more common in hospitalized patients. Nearly half of patients with elevated troponins had at least moderate left ventricular (LV) dysfunction, which was associated with doubled risk of death, comparing to patients with no LV wall motion abnormalities. Myocardial function impairment can be reversible or irreversible. Both left and right ventricular



**Figure 1.** Transthoracic echocardiography in patients with COVID-19 — thrombi (arrows) in the left ventricle (A, B) and in the right ventricle (C).

Abbreviations: Ao, aorta; LA, left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle

dilatation are associated with poor prognosis. Global or regional myocardial injury visible on echocardiography can be detected in up to 25% of hospitalized patients with COVID-19 and is associated with an increased risk of mortality. Intracardiac clots forming on the damaged cardiac endothelium or migrating from the veins to the pulmonary circulation may be observed (Figure 1). Pericardial or pleural fluid initially reported as rare in COVID-19 patients, has been recently more frequently described in the context of perimyocarditis [10]. In a study at least mild pericardial effusion was found in 7.2% of severely ill patients with myocardial dysfunction [10]. Cardiac tamponade was also reported in a case study [11].

Most common clinical indications for TTE in the acute COVID-19 are hemodynamic assessment (including fluid status), rising cardiac biomarkers, suspicion of pulmonary embolism, acute coronary syndrome, heart failure, or myocarditis [13]. Other indications include history of cardiac disease, suspicion of endocarditis, and evaluation for cardioembolic source of stroke [14]. In practice, many TTE tests are performed in mechanically ventilated subjects hospitalized due to COVID-19. Thus, in patients with clinical deterioration, TTE exams (optionally combined with lung ultrasound [LUS] tests and 4-point venous compression ultrasound [CUS]) may be needed to document myocardial dysfunction or other complications indicating the need for early intensive treatment. It is particularly important in patients with preexisting heart disease or comorbidities. In most patients simplified protocols are preferred to limit personnel exposure to infected patients. Advanced analysis (e.g., strain imaging), if considered essential, can be performed offline to document subtle ventricular dysfunction.

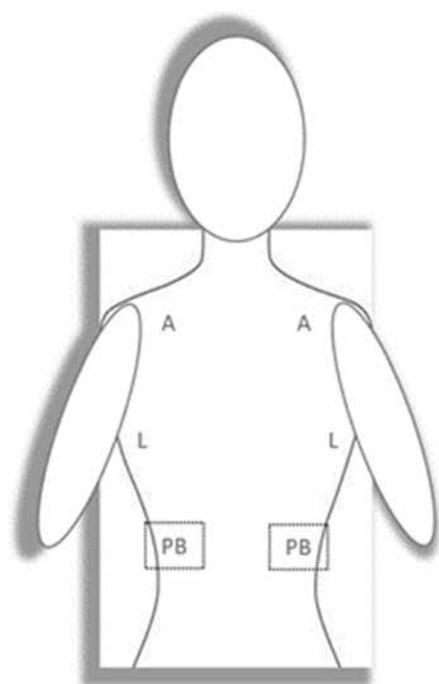
Recovery of the myocardial damage is variable and long-term sequelae may persist, depending on the baseline status, the severity of viral or inflammatory damage, and the speed and completeness of recovery phase.

Some patients may never recover completely following acute COVID-19. Symptom-free convalescents do not require cardiac imaging, however lack of complete recovery is an indication for the control TTE. In most cases, echocardiography should be performed when there is no further risk of infecting the personnel. Subclinical myocarditis may be of some concern, especially in patients with innate or acquired immune deficits. As data is conflicting further studies are needed to assess the long-term cardiac consequences of SARS-CoV-2 infection.

Last but not least, abnormalities detected in COVID-19 or post-COVID-19 patients include also the results of delayed cardiac care, like myocardial infarction (untreated or treated late or without reperfusion) that can be complicated with classical mechanical complications [12]. Delayed diagnosis due to the pandemic can result in late detection of decompensated chronic conditions, such as valvular disease (predominantly aortic stenosis, mitral and tricuspid regurgitations) or heart failure of any origin.

## LUNG ULTRASOUND

Radiography and computed tomography remain the mainstay for evaluation of COVID-19 pneumonia. Although LUS has proven its diagnostic value and capability in COVID-19 patients, it lacks standardization and suffers from the absence of quantitative approaches. Importantly, LUS findings are nonspecific for COVID-19. A diffuse pattern of B-lines, irregular pleural lines, and subpleural consolidations affecting mainly the lower lobe and posterior lung segments, which show a bilateral, patchy, and peripheral pattern, represent typical LUS findings in COVID-19 pneumonia [15].



**Figure 2.** Simplified 3-zone protocol for bilateral lung ultrasound examination for cardiologists. Anterior (A), lateral (L), and postero-basal (PB) lung zones are examined

There is still great variability regarding the optimal technique, including different proposed scanning protocols and scoring algorithms. For this reason, Italian experts proposed standardization for international use of LUS for the management of patients with COVID-19 [16]. Fourteen standard areas (7 areas per lung) are suggested for scanning in each patient, using landmarks on chest anatomic lines (3 posterior — paravertebral line; 2 lateral — mid-axillary line; 2 anterior — mid-clavicular line). In the absence of a standardized score for COVID-19 patients, Italian experts proposed to use a previously validated scoring system. The final score is obtained by summing up the scores of each area. Some studies suggested that a higher LUS score indicating a poorly aerated lung and a more severe pulmonary involvement may thus be useful for predicting adverse outcomes in patients with COVID-19, and important for risk stratification in COVID-19 patients [17]. Canadian experts described the 6-zone (3 zones per lung) protocol aimed at speeding up and simplifying the examination dedicated for cardiologists (posterior basal, lateral and anterior — for each lung), and we propose to use this protocol (Figure 2) [18].

According to the experience and reports of many groups throughout the world, even with a rather empirical approach, LUS seems to be an useful, radiation-free, bedside method which can be applied after the TTE examination. Current enthusiasm for LUS should lead to high-quality controlled studies which can determine its real utility among COVID-19 patients.

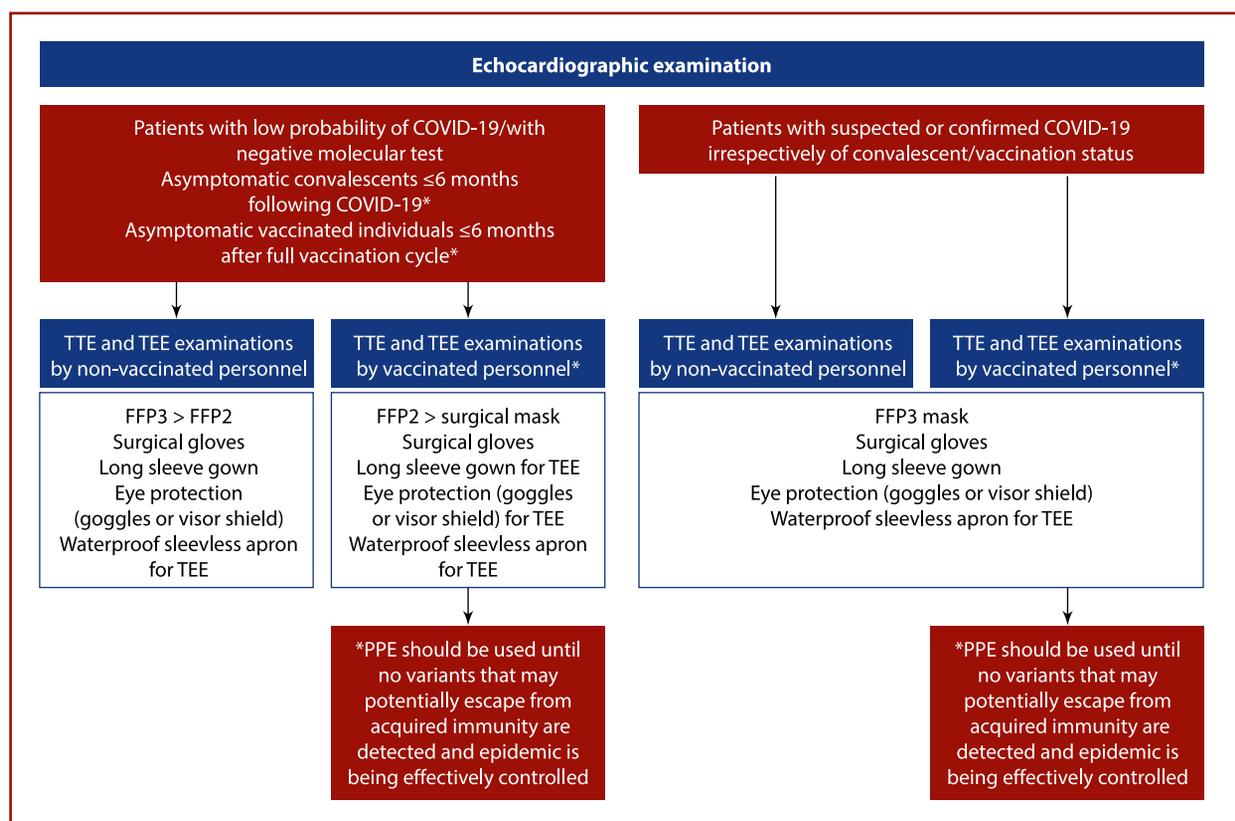


**Figure 3.** Web-based lung ultrasound simulator ([www.lus.mstech.eu](http://www.lus.mstech.eu)). The probe is dragged over the chest with a computer mouse. The user recognizes typical artifacts (here B-lines), which are then assigned to the standard lung ultrasound points. The findings are then verified and corrected in case of errors

Despite the fact that currently there is no clear data showing that LUS improves outcomes, the COVID-19 era poses unprecedented challenges, but also learning opportunities. Web based ultrasound simulators are available for training (Figure 3) [19].

### COLLATERAL DAMAGE TO CARDIOVASCULAR HEALTHCARE

The COVID-19 pandemic has significantly impacted healthcare systems around the world, including echocardiography laboratories. A large portion of available resources has been repurposed towards fighting the pandemic. The remaining available cardiology departments and personnel have been often advised to defer scheduled elective procedures, especially those associated with increased risk of SARS-CoV-2 transmission, such as transesophageal echocardiography [1]. Moreover, patients' fear of infection and the desire to not overburden the healthcare system have also been keeping them from seeking medical care in case of symptoms unrelated to COVID-19, both in urgent and chronic clinical scenarios [20]. Thus, the COVID-19 pandemic has adversely influenced the care and treatment of cardiovascular patients. The full scope and the long-term consequences of this "collateral damage" are yet to be determined, but the data published so far is already alarming, even though the exact extent of observed detrimental effects varies greatly between reports and affected regions. To date, most studies have concentrated on patients with acute myocardial infarction, indicating lower number of their hospital admissions, higher rate of delayed presentations and a significant reduction in coronary angiographies and percutaneous coronary interventions [21, 22]. However, the hospitalizations for heart failure and cardiac arrhythmias, as well as the cumulative number of hospitalizations for acute and chronic cardiovascular conditions have also markedly decreased during the pandemic [23]. Similarly, a substantial drop in the number of outpatient cardiovascular visits has been reported, although it was partly compensated using telehealth



**Figure 4.** Suggested personal protection equipment, according to the probability of COVID-19, type of echocardiographic examination, patient and personnel vaccination/convalescent status.

Abbreviations: TEE, transesophageal echocardiography; TTE, transthoracic echocardiography

[24]. There also has been a considerable reduction in the number of inpatient and outpatient cardiac procedures and investigations [25, 26].

With regard to echocardiography, preliminary analysis of the survey study performed by the Working Group on Echocardiography of the Polish Cardiac Society suggests that the vast majority of centers have been performing significantly fewer examinations than before the pandemic. The drop has been most evident in TEE, in case of which indications for examination have been often reevaluated and narrowed, and a negative COVID-19 test prior to the procedure was required in the laboratories on non-COVID-19 wards. Most of the laboratories have also reported temporary shortages of staff due to COVID-19, quarantine or dispatching them to work in infectious disease departments. As a result, there even have been instances of temporary cessation of any activities. Moreover, a significant number of centers have been at least partially transformed to diagnose and treat COVID-19 patients. Thus, waiting times for both scheduled echocardiographic examinations and elective surgical and percutaneous procedures recommended for patients after echocardiographic examinations have been extended. Therefore, it comes as no surprise that a significant increase in out-of-hospital cardiac arrests and deaths was noted in the affected regions [27–29], and was accompanied by substantial overall excess

mortality, which could not be explained by the number of COVID-19 fatalities [30, 31]. All these data call for urgent re-introduction of widely available echocardiography services.

### REACTIVATION OF ECHOCARDIOGRAPHIC LABORATORIES

Despite the current peak of the pandemic, there is an urgent need for restoring full capacity of echocardiographic laboratories. It may be feasible in near future, as an increasing number of staff and patients are already either vaccinated or have recovered from COVID-19. Distinct separation of laboratories providing services for COVID-19 infected or COVID-free patients should be instituted, if logistically possible. Echocardiographic laboratories that are not directly involved in the care of COVID-19 patients should attempt to return to their full pre-pandemic activity and perform all study types, according to standard protocols, as well as try to alleviate collateral damage to the services caused by COVID-19. Waiting lists for echocardiographic examinations should be verified as prolonged waiting period for echocardiography examination has become a serious issue. Urgent patients for whom further delays may be life-threatening should be placed on a priority list (e.g., decompensated heart failure, severe aortic stenosis).

Although access to echocardiographic services should be urgently facilitated, all essential restrictive precautions and

**Table 1.** Recommendations for echocardiographic laboratory organization

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Laboratories providing services for COVID-19 and non-COVID-19 patients should be separated, if logistically possible
Echocardiographic laboratories providing services for non-COVID-19 patients should return to their pre-pandemic level of activity
Patients with urgent indications for whom further delays may be life-threatening should be prioritized

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**Table 2.** Recommendations for non-COVID-19 in-patient echocardiographic services

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In-patient echocardiographic laboratories in non-COVID-19-dedicated wards should return to their pre-pandemic activity and perform all test types according to standard protocols
Decisions on the reinstatement of "lockdowns" of regular echocardiographic services should be made on the local basis rather than national basis
With regard to COVID-19 testing, echocardiography laboratories should follow local hospital policies and existing legal requirements
When/if the pandemic is under control (as defined above), preventive measures may be eased
We do recommend however that appropriate personal protective equipment should be always available/used during echocardiographic examinations in hospital settings until the end of the pandemic

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safety measures should be preserved, to minimize the risk of infecting other patients and medical personnel at the peak of the pandemic. Decrease of the number of cases following an effective vaccination program may however enable to modify some protective measures or get away from them in the future. It is therefore strongly recommended that every member of an echo team be vaccinated against SARS-CoV-2.

Echocardiographic protocols should be differentiated according to the location of the echocardiographic laboratory (in-patient vs outpatient, COVID-19 vs non-COVID-19 services) and the epidemiologic status of the patients examined. When separation of COVID-19 and non-COVID-19 patients is impossible for logistic reasons, patient management should include isolation of infectious patients and case grouping, possibly at the end of the day, to ensure appropriate personnel protection and disinfection of the facilities. For recommendations see also [Table 1](#), [Figure 4](#).

### **Recommendations for non-COVID-19 in-patient echocardiographic services**

Echocardiography laboratories in COVID-19-free wards should perform full range of examinations, following standard protocols. Intraprocedural TTE and TEE monitoring should also be reinstated. At the peak of the pandemic, SARS-CoV-2-free status of non-vaccinated patients without COVID-19 symptoms should be confirmed through appropriate institutional screening procedures, including *reverse-transcription polymerase chain reaction* (RT-PCR) testing for the presence of SARS-CoV-2 immediately prior to admission and at the wards, according to local hospital policy and existing legal requirements. Surgical gloves and FFP2 masks (if available) should be used at all times during echocardiographic examinations in hospital settings.

Vaccinated patients without symptoms of infection, may be considered as having minimal probability of being infectious, at least for the 6 months after an index event. Therefore, when/if the pandemic is under control (as defined above), preventive measures may be relaxed. However we do recommend that appropriate personal protective equipment should be always available/used during echocardiographic examinations in hospital settings until

the end of the pandemic. Exceptions may be considered only for contacts between fully vaccinated individuals. For recommendations see also [Table 2](#), [Figure 4](#).

### **In-patient COVID-19 echocardiographic services**

The rules and procedures concerning echocardiography examination in COVID-19 wards do not change. Full personal protection must be available for every test (TTE, TEE), including those of potentially infected patients awaiting definite diagnostic test result. Minimum standards of personal protection as proposed below may be locally tightened up, according to local policies and pandemic situation. Complete disinfection of the lab and equipment should be performed on a regular basis as per local standards. Due to intense personal contact, every test ordered should have the potential to influence the management. The duration of TTE examination should be minimized and focused protocols are recommended to obtain the most important and clinically useful information quickly. If possible, analyses and measurements should be performed off-line to focus on problem-oriented examinations, facilitate therapeutic decisions, and minimize the risk of infecting medical personnel. Performing stress-testing during acute COVID-19 is contraindicated. It is the responsibility of hospital administration to ensure digital data transfer to reading lab with workstations to ensure analysis quality and safety. For recommendations see also [Table 3](#) and [Figure 4](#).

### **Out-patient echocardiographic services**

Access to echocardiographic services is of key importance to ascertain reinstatement of routine care, especially for heart failure and structural heart disease patients. Out-patient echocardiographic services should therefore remain open; however, in patients with suspected COVID-19 (based either on their symptoms or contact history) or other respiratory infection, routine echocardiography should be postponed until COVID-19 diagnosis is excluded by the RT-PCR test or until the risk of transmission is considered minimal (usually no less than 10 days after symptom onset).

Until the pandemic is under control, both vaccinated and unvaccinated patients without clinically suspected COVID-19 should wear face mask in echo lab. Enhanced

**Table 3.** Recommendations for COVID-19 in-patient echocardiographic services

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Recommendations for the COVID-19 patients and patients with unknown SARS-CoV-2 status remain unchanged, and all TTE and TEE studies must be performed with full personal protection, regardless of the vaccination status of the personnel

Indications for tests should remain restrictive with predictable influence upon clinical management

Echocardiographic protocols should be shortened

Whenever possible analyses and measurements should be performed off-line, outside the infectious zones and digital data transfer and analysis is encouraged

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Abbreviations: TEE, transesophageal echocardiography; TTE, transthoracic echocardiography

**Table 4.** Recommendations for out-patient echocardiographic services

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Out-patient echocardiographic laboratories should return to their pre-pandemic activity and perform all test types, according to the standard protocols

Stress echocardiography services should be reinstated, and most of the protocols (except for rapid pacing) must be considered as aerosol-generating and personnel protection level should equal to that proposed for TEE

In patients with suspicion of COVID-19 (based either on their symptoms or contact history) or ongoing respiratory infection routine echocardiography should be postponed until COVID-19 diagnosis is excluded by the RT-PCR test or until the risk of transmission is considered minimal (usually no less than 10 days after symptom onset)

Vaccinated patients and convalescents without symptoms of infection should be considered as SARS-CoV-2 negative, at least for 6 months after an index event, unless new SARS-CoV-2 variants with demonstrated vaccine resistance are present in the community;

Routine screening of asymptomatic individuals using RT-PCR tests before TTE is not recommended;

Routine screening of asymptomatic individuals using RT-PCR tests before TEE may be considered, based on the local prevalence of COVID-19 cases;

Antigen testing for screening asymptomatic patients is not recommended;

Face masks should be worn by patients and medical personnel during TTE

Transducers must undergo disinfection after each study

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Abbreviations: RT-PCR, reverse-transcription polymerase chain reaction; other abbreviations: see [Table 3](#)

personal protection is suggested in personnel prior to full vaccination, in cases of immune deficiencies or in case of emergent virus variants that may reduce vaccination efficacy. During TTE the echocardiographic laboratory staff should wear FFP2 or surgical masks (as per local policy) and probes must be disinfected between tests.

Transesophageal echocardiography during the SARS-CoV-2 pandemic is recognized as a high-risk aerosol-generating procedure. In the early stages of the pandemic, indications were limited to emergency, in which test findings were crucial for the diagnostic and therapeutic processes. Currently it is recommended to reestablish full TEE echocardiographic services in patients without COVID-19, including patients with indications for structural interventions, catheter ablation, and other procedures. However RT-PCR tests must be obligatory for patients with suspected respiratory infection, as per general testing strategy, to avoid contamination of laboratories remaining in COVID-free status, while personnel protection for TEE should be implemented regardless of patients' status. At the peak of the pandemic, elective TEEs should be preceded by negative COVID-19 results also in apparently asymptomatic non-vaccinated patients. Medical personnel should always use personal protective equipment against airborne infections during TEE, irrespectively of the patient's status. Full protective gear including FFP3 face mask, eye protection (goggles or shields), and full barrier uniform is prerequisite when TEE is performed in an infected patient. When/if the pandemic is under control (as defined above), TEE examinations in asymptomatic patients need not be preceded by RT-PCR COVID-19 testing. We do recommend, however, that surgical gloves and FFP2 (or FFP3) masks should be

always used, until the end of the pandemic. Exceptions may be considered only for contacts between fully vaccinated individuals.

Stress echocardiography is a valuable option in non-COVID patients and services must be also reintroduced. Most types of stress echo (except for pacemaker rapid stress-testing) carry the risk of hyperventilation and aerosol generation, and, therefore, should be performed according to sanitary standards, like TEE in non-COVID facilities. Therefore, until the pandemic is under control, in non-pacemaker stress tests medical personnel should always use personal protective equipment against airborne infections, including FFP2 (optimally FFP3) face masks, disposable insulating gowns, protective eyewear and gloves.

Once the pandemic is under control, exceptions may be considered for contacts between fully vaccinated individuals. For recommendations see also [Table 4](#) and [Figure 4](#).

### **Impact of vaccination on echocardiographic services**

The efficacy of both mRNA vaccines has been confirmed in pivotal randomized clinical trials with over 70 000 participants, including 40.9% and 42% high risk individuals and demonstrating over 95% efficacy [32, 33]. Real life data from United Kingdom (UK) and Israel, where effective vaccination programs were launched, confirm mRNA (UK and Israel) and adenoviral vaccine (UK only) efficacy. Vaccination programs proved their effectiveness also among healthcare workers [34]. Therefore, given confirmed efficacy and safety of mRNA vaccines as well as high morbidity and mortality associated with COVID-19 infections [35], we recommend universal vaccination of medical personnel and patients.

**Table 5.** Recommendation for vaccination of medical personnel

Experts recommend that ALL medical personnel working in the echocardiographic laboratories should be vaccinated against COVID-19 as soon as possible, regardless of antibody status or previous COVID infections, unless absolute contraindications exist (see relevant Summaries of Product Characteristics)  
Time between the first and the second dose of the vaccine should be as short as possible (in case of two-dose vaccination schemes)

There is limited data about the durability of protection from the vaccines therefore this recommendation may be updated based on the available new data, but currently it is reasonable to assume that immune memory to SARS-CoV-2 lasts longer than 6 months. This may be assumed provided that no mutation is present that reduces acquired convalescent immunity and/or vaccine efficacy. For recommendations see also [Table 5](#).

### **The use of personal protective equipment in the context of vaccination programs and the presence of convalescents**

This paper builds upon previous authors' position statements, as far as personnel protection equipment (PPE) is concerned, but with some important modifications. Patients were previously classified into three groups:

- with confirmed COVID-19;
- with suspected COVID-19 (either symptomatic or identified by contact tracing but with unknown PCR), and
- with low probability of COVID-19 (no signs of respiratory infection and/or other early COVID symptoms, including those with recent negative molecular test).  
Two groups are added to this classification:
- convalescents within 6 months following COVID-19 and
- vaccinated individuals within 6 months following a completed vaccination, at least 7 days after the second dose (recommendations may be extended over the next 6-month period once more complete data on the mid-term vaccine efficacy is available).

### **Recommendations regarding personal protective equipment use in the echocardiographic laboratories**

Non-vaccinated healthcare professionals (including those who received only one dose of the vaccine) should keep on wearing previously recommended adequate PPE including FFP3 masks or equivalent respirators, appropriate gown and eye protection while performing examinations in groups 1 and 2. If PPE supplies are adequate, healthcare professionals examining group 3 patients should wear FFP2 masks rather than surgical masks (changed recommendation) until the pandemic is under control. The same recommendations apply to vaccinated healthcare professionals. In the case of asymptomatic patients belonging to groups 4 and 5 the following recommendations apply:

- non-vaccinated healthcare professionals (including those who received only one dose of the vaccine) should continue wearing previously recommended adequate PPE including FFP2 or FFP3 masks or equivalent respirators;

- vaccinated healthcare professionals (only those who received full cycle) should wear previously recommended, adequate full PPE for TEE with FFP2 mask rather than surgical mask, until the pandemic is under control;
- for TTE, FFP2 masks rather than surgical masks should be worn, together with disposable gloves, until the pandemic is under control;
- recommendations may be eased, when the pandemic is under control, but despite the fact that some regulators accept fully vaccinated people gathering indoors without masks, we propose that until the end of the pandemic also vaccinated personnel and patients should wear face masks, especially during aerosol-generating procedures like echocardiographic examinations.

It is important to note that current recommendations have been issued at a time of uncontrolled spread of the infection and in the absence of robust national systems for emergent virus variants tracking, and the lack of sufficient knowledge about the efficacy of the vaccines towards these variants. Therefore, authors recommend echocardiographic laboratory directors to regularly update their knowledge about the COVID-19 pandemic.

### **Article information**

**Conflict of interest:** None declared.

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