

# Research letter

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## The clinical and prognostic role of echocardiography in ‘SARS-CoV-2’ disease

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An increasing number of articles have been published in the last months describing echocardiographic findings in patients with ‘severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)’ [coronavirus disease (COVID)] disease [1]. Nevertheless, the clinical and prognostic role of this methodology is far to be defined due to the extreme heterogeneity of findings, referable to different factors. First, a patient bias selection, because some societies [1,2] state that an echocardiogram should be performed only in ‘selected’ patient, due to potential infectious risks for personnel staff. Second, study populations differ for disease severity (mild–moderate vs. severe disease) and ventilation mode (spontaneous breathing vs. noninvasive and invasive ventilation). Lastly, all studies are observational studies, in which different echocardiographic parameters have been measured according to different local protocols.

We summarized the available evidence on this topic aiming at describing potential differences in echocardiographic findings in mild–moderate (non-ICU) patients and in severe (ICU) ones. The goal was to detect eventual distinct clinical significance of this methodology in these two different clinical settings.

Table 1 shows the studies reporting echocardiographic findings in COVID patients according to disease severity.

Only two studies included solely noncritical COVID patients [3,4]. Rath *et al.* [3] observed that left ventricle ejection fraction (LVEF) was independently associated with mortality, while right ventricle (RV) stress (as indicated by RV failure and pulmonary arterial hypertension) resulted to be related to a poor prognosis in both studies [3,4] in whom echocardiography was performed routinely (with no inclusion restriction).

Three studies specifically addressed more severe COVID patients needing ICU admission [5–7]. Evrad *et al.* [5] compared echocardiographic findings in COVID patients (transesophageal echocardiography) with those observed in flu-related acute respiratory distress syndrome (ARDS).

Patients with COVID-related ARDS showed a lower prevalence of LV and RV failure in respect to those with flu-related ARDS. These data are to be considered preliminary, because the small number of patients included (COVID: n. 18) and the lower mortality rate reported in ICU patients with COVID-ARDS (6%). When serial echocardiographic examinations were performed [6], systolic pulmonary arterial pressures were found to be increased in all COVID patients on ICU admission (n. 28, mostly mechanically ventilated) but they significantly decreased during ICU stay. The increase in systolic pulmonary arterial pressures could be related to the hypoxic vasoconstriction in compliant lungs, factors which seems to characterize COVID-19-related ARDS, although mechanical ventilation itself might represent also a contributing factor (by increasing RV afterload). An interesting protocol, combining lung and cardiac ultrasound, was presented by García-Cruz *et al.* [7] and implemented in 82 COVID patients admitted to ICU. The most frequent ultrasonographic findings were elevated pulmonary artery systolic pressure (69.5%), LV diastolic dysfunction (indicated by E/e' ratio > 14, 29.3%), and RV abnormalities (dilatation in 28% and dysfunction in 26.8%). Elevated pulmonary artery systolic pressure was associated with higher in-hospital mortality.

Most studies [8–13] were performed in a mixed population and common bias for inclusion characterized many of these studies in whom echocardiography was performed in ‘selected patients’, because most often the appropriateness of the examination was assessed on a case by case basis by the attending cardiologist [11–13].

In a retrospective analysis (749 patients) [13], transthoracic echocardiography was performed only in 72 patients (9.6%, the majority on mechanical ventilation), mainly for a suspected major cardiovascular event and hemodynamically instability. Nevertheless, echocardiographic findings changed management in about one-fifth of patients (24.2%). In a retrospective analysis (112 patients), Deng *et al.* [12] focused on the incidence of myocardial injury, assessed by serial measurements of troponin values while echocardiography was performed only once. Troponin levels increased during hospitalization in 37.5% of patients, but, in the absence of typical signs of myocarditis on echocardiogram and ECG, the authors concluded that in COVID disease myocardial injury was more likely related to systemic consequences rather than direct damage by COVID. A direct relationship between troponin and C reactive protein was described in a small cohort of ICU patients [6]. Comparing nonsevere (n. 45) and

Table 1 Investigations according to disease severity

	Country	Study population	Main findings	Limitations	Conclusions
ICU					
Evrard <i>et al.</i> [5]	France	18 COVID patients vs. 23 flu patients. TEE evaluation.	In COVID a lower prevalent of LV failure [(17 vs. 61%) ACP (17 vs. 48%)].	Not reported	In hemodynamically ventilated COVID-19 patients, a lower prevalence of LV and RV failure than in flu-related ARDS patients.
Lazzeri <i>et al.</i> [6]	Italy	28 COVID-related ARDS.	On admission: on admission, acute core pulmonale was detected in two patients (2/28, 7%). Increased systolic arterial pressure was detected in all patients.	Observational single-center investigation.	(1) increased Tn levels, although common, was not associated with echo wall motion abnormalities; (2) a significant direct relationship was detectable between Tn and C-reactive protein. (3) Systolic pulmonary arterial pressures were increased in all patients on ICU admission but significantly decreased during ICU stay.
Mixed population					
Zeng <i>et al.</i> [8]	Republic of China	416; ICU: 35, non-ICU: 381 Echocardiographic data (ICU: 31 patients, non-ICU: 26 patients).	Pulmonary hypertension (29 vs. 0%) and reduced LVEF (16 vs. 0%) more common in ICU patients.	Echocardiography was performed in a small subset of patients (57/416, 14%).	Cardiac complications (acute cardiac injury, arrhythmias, and acute heart failure) were more frequent in ICU patients.
Mahmoud-El-sayed <i>et al.</i> [9]	UK	74 patients (proven pneumonia).	The chief abnormalities were right ventricle (RV) dilatation (41%) and RV dysfunction (27%).	TTE was restricted to patients with COVID pneumonia with elevated troponin.	RV dilatation and dysfunction are common in patients with COVID-19 pneumonia and elevated troponin.
Dweck <i>et al.</i> [14]	Prospective international survey (3–20 April 2020) 69 countries	1216 patients	667 (55%) patients with an abnormal echocardiogram. Severe cardiac disease (severe ventricular dysfunction or tamponade) was observed in 182 (15%) patients. Echocardiography changed management in 33% of patients.	Observational study. Some information were collected from free-text fields. No data on outcome.	In this global survey, cardiac abnormalities were observed in half of all COVID patients undergoing echocardiography. Imaging changed management in one-third of patients.
Li <i>et al.</i> [10]	China	157 hospitalized COVID patients	RV dysfunction was found in 25.5%. Troponin elevation, mechanical ventilation, and RV dysfunction were independent predictors of higher mortality.	Not reported	The prevalence of RV dysfunction was higher than that of LV dysfunction in patients with COVID.
Szekely <i>et al.</i> [11]	Israel	100 patients	The most common cardiac pathology was RV dilatation and dysfunction (observed in 39% of patients), followed by LV diastolic dysfunction (16%) and LV systolic dysfunction (10%).	Only hospitalized (for at least 24 h) patients with COVID infection. The fact that only ≈7% of patients diagnosed with COVID infection in Israel are admitted to the hospital probably led to an overestimation of the severity of echocardiographic pathology in COVID infection.	LV systolic function is preserved in the majority of patients, but LV diastolic function and RV function are impaired.
Non-ICU					
Rath <i>et al.</i> [3]	Germany	123 patients at hospital admission.	LV and RV as well as tricuspid regurgitation >grade 1 were significantly associated with higher mortality.	Not reported	Cardiac failure is associated with poor prognosis in patients COVID infection.
Deng <i>et al.</i> [12]	China	112 patients	LV < 50% (5.4%). Pulmonary hypertension (13.4%).	Echocardiography was performed on demand.	Myocardial injury is related to systemic consequences in absence of echocardiographic signs of myocarditis.
Jain <i>et al.</i> [13]	USA	72 patients underwent TTE (72/740 COVID patients).	LV < 50%: 34.7%, RV dysfunction: 13.9% Clinical management was changed in eight individuals (24.2%).	TTE may have been ordered.	In appropriately selected patients, TTE can be an invaluable tool for guiding COVID-19 clinical management.
Pagnesi <i>et al.</i> [4]	Italy	200 non-ICU patients	The prevalence of pulmonary hypertension and RVD was 12.0% (24/200) and 14.5% (29/200).	The present study focused on pulmonary hypertension and RVD only, not exploring other potential mechanisms and types of cardiac injury during COVID.	Pulmonary hypertension (and not RVD) was associated with signs of more severe COVID and with worse in-hospital clinical outcome.

ACP, acute cor pulmonale; ARDS, acute respiratory distress syndrome; COVID, novel coronavirus; LV, left ventricle; LVEF, left ventricular ejection fraction; RV, right ventricle; RVD, right ventricular dysfunction; TAPSE, tricuspid annular plane excursion; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography.

severe (n. 67) patients [12], no difference was found in the incidence of LV failure (<50%) and RV failure (tricuspid annular plane excursion < 16 mm), while severe patients exhibited a higher incidence of systolic pulmonary hypertension (20.9 vs. 2.2%).

In the first systematic echocardiographic assessment [11], a normal echocardiogram was present in about one-third of patients (32%) and RV dilatation and dysfunction was the most common alteration (39%) being associated with more severe lung disease and higher levels of biomarkers related with adverse prognosis. The baseline echocardiographic parameters associated with mortality were low LVEF, LV diastolic dysfunction (indicated by elevated E/e' ratio), and RV dilatation (RV end-diastolic area).

The relationship between echocardiographic findings and COVID disease severity was assessed by Zeng *et al.* [8] (single-center, 416 patients). Comparing ICU (n. 35) and non-ICU (n. 381), they observed a higher incidence of myocardial injury marker elevation (troponin), ventricular wall thickening, pulmonary artery hypertension, and cardiac complications including acute myocardial injury, arrhythmia, and acute heart failure in ICU patients.

In a prospective survey [14] (1272 COVID patients), a normal echocardiogram was described in half of the entire population (45%) but in one-third of patients who underwent echocardiography on clinical indication, imaging was reported to result in an immediate change in patient management. The main finding of this survey is that echocardiographic alterations were detectable in one in seven patients across the entire population and in one in eight patients without pre-existing cardiac disease. This proportion rose to one in five when the indication for imaging included increased cardiac biomarkers.

Overall, data on mixed COVID population (non-ICU and ICU) point out those cardiac alterations are quite common, being RV dysfunction and pulmonary hypertension more prevalent, and associated with prognosis. Moreover, echocardiographic findings are related to disease severity being RV dilatation/dysfunction, systolic pulmonary

hypertension, and myocardial injury more common in severe disease.

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### Conflicts of interest

There are no conflicts of interest.

## References

- Garcia-Castrillo L, Petrino R, Leach R, Dodt C, Behringer W, Khoury A, Sabbe M. European Society for Emergency Medicine position paper on emergency medical systems' response to COVID-19. *Eur J Emerg Med* 2020; **27**:174–177.
- 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 care echocardiography training: report from the American Society of Echocardiography. *J Am Soc Echocardiogr* 2020; **33**:409–422.e4.
- Rath D, Petersen-Urbe A, Avdiu A, Witzel K, Jaeger P, Zdanyte M, *et al.* Impaired cardiac function is associated with mortality in patients with acute COVID-19 infection. *Clin Res Cardiol* 2020; **109**:1491–1499.
- Pagnesi M, Baldetti L, Beneduce A, Calvo F, Gramegna M, Pazzanese V, *et al.* Pulmonary hypertension and right ventricular involvement in hospitalised patients with COVID-19. *Heart* 2020; **106**:1324–1331.
- Evrab B, Goudelin M, Montmagnon N, Fedou AL, Lafon T, Vignon P. Cardiovascular phenotypes in ventilated patients with COVID-19 acute respiratory distress syndrome. *Crit Care* 2020; **24**:236.
- Lazzeri C, Bonizzoli M, Batacchi S, Cianchi G, Franci A, Fulceri GE, Peris A. Cardiac involvement in COVID-19-related acute respiratory distress syndrome. *Am J Cardiol* 2020; **132**:147–149.
- Garcia-Cruz E, Manzur-Sandoval D, Rascón-Sabido R, Gopar-Nieto R, Barajas-Campos RL, Jordán-Ríos A, *et al.* Critical care ultrasonography during COVID-19 pandemic: the ORACLE protocol. *Echocardiography* 2020; **37**:1353–1361.
- Zeng JH, Wu WB, Qu JX, Wang Y, Dong CF, Luo YF, *et al.* Cardiac manifestations of COVID-19 in Shenzhen, China. *Infection* 2020; **48**:861–870.
- Mahmoud-Elsayed HM, Moody WE, Bradlow WM, Khan-Kheil AM, Senior J, Hudsmith LE, Steeds RP. Echocardiographic findings in patients with COVID-19 pneumonia. *Can J Cardiol* 2020; **36**:1203–1207.
- Li Y, Li M, Zhang L, Xie M. The prevalence, risk factors and outcome of cardiac dysfunction in hospitalized patients with COVID-19. *Intensive Care Med* 2020; **46**:2096–2098.
- Szekely Y, Lichter Y, Taieb P, Banai A, Hochstadt A, Merdler I, *et al.* Spectrum of cardiac manifestations in COVID-19: a systematic echocardiographic study. *Circulation* 2020; **142**:342–353.
- Deng Q, Hu B, Zhang Y, Wang H, Zhou X, Hu W, *et al.* Suspected myocardial injury in patients with COVID-19: evidence from front-line clinical observation in Wuhan, China. *Int J Cardiol* 2020; **311**:116–121.
- Jain SS, Liu Q, Raikhelkar J, Fried J, Elias P, Poterucha TJ, *et al.* Indications for and findings on transthoracic echocardiography in COVID-19. *J Am Soc Echocardiogr* 2020; **33**:1278–1284.
- Dweck MR, Bularga A, Hahn RT, Bing R, Lee KK, Chapman AR, *et al.* Global evaluation of echocardiography in patients with COVID-19. *Eur Heart J Cardiovasc Imaging* 2020; **21**:949–958.

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