

The role of ultrasound for patients with suspected or proven COVID-19

Introduction

Point of care ultrasound (POCUS) is currently being used internationally in the management of patients with COVID-19 infection and has been widely reported. Lung ultrasound shows typical sonographic signs. Cardiac ultrasound reveals effects on the heart. Different healthcare systems worldwide have different capacities, logistical considerations, and diagnostic and management pathways. With this in mind, UK guidance would seem appropriate. This document briefly outlines potential indications and uses of POCUS and how, when and by whom it should be performed. Sonographic features of COVID-19 are also described.

Indications - diagnosis and triage

Lung ultrasound: Identification of ultrasound signs consistent with viral interstitial pneumonia / non-cardiogenic pulmonary oedema, to facilitate early identification of patients who may have COVID-19 as opposed to alternative lung pathologies. This may have benefits in terms of patient triaging, and early routing of patients to the appropriate location. There may also be a role in identifying low probability / severity cases requiring less intensive early input. Anecdotal reports from Italy and elsewhere suggest lung US may have a better sensitivity for detection of COVID-19 than swabbing.

Cardiac ultrasound: Identification of significant co-morbidities and assessing cardiac function at symptom onset.

Indications - management

Alternative causes of deterioration in the context of worsening clinical condition:
These may include acute cardiomyopathy, evidence consistent with pulmonary embolism, evidence consistent with secondary, super-added infection, pleural effusions and pneumothorax.

Ventilation strategies:

Lung recruitment - in intubated patients with COVID-19 associated respiratory failure, and on-going / worsening hypoxia, in whom different treatment strategies are being considered, POCUS may differentiate two lung patterns; 1) bilateral, diffuse, anterior, multiple B-line with pleural abnormalities vs 2) 'normal' anterior lung (or anterior lobar consolidation) with postero-lateral / basal atelectasis / consolidation. These two patterns may identify patients who are better treated with increased PEEP trials (pattern 1) or prone ventilation (pattern 2). There is no solid outcome evidence for this, but according to units that have treated many COVID-19 patients this is an appropriate algorithm.

Lung aeration - as the lung goes from aerated to non-aerated, lung ultrasound appearances progress from A lines → a few B lines → lots of B lines → coalesced B lines → consolidation.

Weaning - resolution of pathological signs to an A line pattern signifies disease resolution.

Fluid balance:

Monitoring of extra-vascular lung water in patients who suffer primarily from respiratory failure.

Monitoring of haemodynamic features of intravascular volume status in patients with cardiovascular instability.



Cardiac function:

Monitoring of right heart function in patients who are at risk of suffering acute cor pulmonale secondary to either hypoxic vasoconstriction and / or ventilator induced lung injury. Left heart function may also be assessed as COVID-19 patients can develop acute cardiomyopathy, presumably secondary to viral myocarditis.

Avoidance of alternative imaging:

The Royal College of Radiologists has released a statement that routine CT scanning of these patients is not indicated ([link to - https://www.rcr.ac.uk/college/coronavirus-covid-19-what-rcr-doing/rcr-position-role-ct-patients-suspected-covid-19](https://www.rcr.ac.uk/college/coronavirus-covid-19-what-rcr-doing/rcr-position-role-ct-patients-suspected-covid-19)). Transfers to CT are resource intensive, time consuming and have significant infection control risks. Lung ultrasound will significantly reduce the need for either chest x-rays or CT scans.

When?

The indications above state when POCUS may be beneficial. Demands on the service will dictate how often it is practical to perform ultrasound. There should always be a clear clinical question where the answer is likely to significantly contribute to patient care. This is, of course, a professional judgement call. Ultrasound is, by no means, the most important thing in these patients. Lung protective ventilation and strict avoidance of a positive fluid balance are the mainstays of management. Ultrasound does however have a role in monitoring and guiding these two treatment strategies.

By whom?

Ultrasound training should ideally be delivered in the manner in which the FUSIC and FAMUS modules have been developed; with education, mentored learning and assessment. Cardiac ultrasound is more difficult to learn and has more pitfalls than lung ultrasound and for the COVID-19 pandemic this advice remains in place. However, lung ultrasound is easier to learn, particularly with a modified data set (*see below*). In the context of the potential need to rapidly up-skill an untrained workforce to deal with the COVID-19 pandemic, and the potentially important beneficial role focused lung ultrasonography can play in the management of these patients, we have created some information highly pertinent to the anticipated case-mix that may be utilised to manage them from diagnosis to later treatment. Whilst in every case imaging should ideally be reviewed by a trained expert, it is hoped that this information may help those without easy access to this to look after their patients, and potentially entice them towards full training at a later stage. The committee wishes every practitioner of ultrasonography all the best in utilising their valuable skills in this challenging time ahead.

How?

A video of how to perform a full FUSIC lung ultrasound can be found at (*Coming soon*). A flowchart of how to perform and interpret lung ultrasound in a focused COVID-19 exam can be found at ([link to http://www.ics.ac.uk/ICS/Pdfs/FUSIC_DOCS/FUSIC_COVID-19_Lung_ultrasound_dataset.aspx](http://www.ics.ac.uk/ICS/Pdfs/FUSIC_DOCS/FUSIC_COVID-19_Lung_ultrasound_dataset.aspx)). An infographic 'how to' with examples of pathology can be found at (http://www.ics.ac.uk/ICS/Pdfs/FUSIC_DOCS/FUSIC_COVID19_info.aspx). Each lung is examined at 3 points - upper anterior, lower anterior and postero-lateral. Normal signs are a clearly seen, thin pleural line with A-line artefacts below the pleura. Pathological signs are outlined below.



Infection control:

Infection control is paramount. National and local guidance on PPE should be followed. Information on machine decontamination can be found at (http://www.ics.ac.uk/ICS/Pdfs/FUSIC_DOCS/FUSIC_decontamination_guidelines.aspx). It would be ideal to have a dedicated machine for cohorted patients or a handheld device for single patient use.

Remote supervision:

NHSX have set out COVID-19 guidance on the use of mobile messaging and videoconferencing using off the shelf products like WhatsApp. This is deemed appropriate “where there is no practical alternative and the benefits outweigh the risk”. This guidance can be found at (link to <https://www.nhsx.nhs.uk/key-information-and-tools/information-governance-guidance>)

Sonographic features

Lung ultrasound

As would be expected for interstitial pneumonia and ARDS:

B lines - often non-homogenous with spared areas, increasing in number with severity, coalesced with ‘white lung’ appearance with severe disease.

Thickened or irregular pleural line

Small consolidations immediately below the pleural line

Lobar consolidation: Severe disease, fluid overload, super-added bacterial pneumonia

Pleural effusions: Unlikely to be present in early disease, may suggest an alternative pathology if significant; later a potential sign of fluid overload.

Recovery phase - transition back to normal appearance (A-lines)



Heart ultrasound

A focused scan can give valuable information. A more detailed expert scan will be appropriate in certain circumstances.

FUSIC heart / FICE practitioners:

LV - systolic impairment; significant dilatation,

RV - systolic impairment (TAPSE, eyeballing contractility); volume/pressure overload (dilatation),

Expert / level 2 practitioners:

Quantification of:

LV and RV function

Identification of:

Raised LV end diastolic pressure

Raised PA pressure

Low pre-load (low stressed venous volume)

Volume overload

Other

Venous congestion - dilated IVC plus abnormal Doppler flow patterns in HV, PV or renal vein signifying high venous pressures from cor pulmonale or fluid overload

Conclusion

Ultrasound is having, and will continue to have, a significant impact on the care of COVID-19 patients during this pandemic. In particular, lung ultrasound is easy to learn, quick to deliver, and impacts on the patient pathway from triage through to intubation and beyond. We believe that the more people that use it the better. Clinicians will become better diagnosticians, and patients will be spared unnecessary radiation and transfers. WhatsApp, FaceTime and other videoconferencing apps may revolutionise how supervision is delivered, with positive effects felt long after the pandemic is over.