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Ultrasound on the Frontlines of COVID-19: Report From an International Webinar

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47 ACR guidelines on radiography in COVID-19 suggest portable CXR when it is considered
48 “medically necessary”.³ Further data is needed on the sensitivity, specificity, and diagnostic
49 impact of CXR on suspected and diagnosed COVID-19 patients.

50 51 Ultrasonography

52 Ultrasound of the lung utilizes artifacts and findings at the lung periphery, and early
53 reports show that abnormal findings are common in COVID-19 patients. A series of twenty
54 patients with COVID-19 described thickening and irregularity of the pleural line, a variety of B-
55 line patterns and subpleural consolidations. Pleural effusions were rare.⁶ A recent comparison of
56 imaging modalities in intensive care patients suffering from acute respiratory failure
57 demonstrated high agreement between lung ultrasound and CT. Ultrasound out-performed chest
58 radiography particularly when assessing interstitial pathologies, as well as ground glass opacities
59 and consolidations.⁶ Since the sensitivity of CT is high in COVID-19 patients and progression of
60 disease is apparent, it is likely that lung ultrasound closely mirrors the longitudinal changes
61 found through CT. High sensitivity and specificity of lung ultrasound seen in acute respiratory
62 distress syndrome (ARDS) as well as in H1N1 influenza suggest that similar test characteristics
63 exist for lung ultrasound in COVID-19. Lung ultrasound also shows prognostic capabilities in
64 ARDS before hypoxemia becomes evident.⁷ While reports on lung ultrasound in COVID-19 are
65 preliminary, they suggest ultrasound findings are likely more common than findings on plain
66 chest radiography. POCUS may also identify and exclude other pulmonary causes of dyspnea as
67 well as cardiac abnormalities. Future research should further specify test characteristics of
68 ultrasound in COVID-19, as well as assessments of harm to ultrasound operators who risk
69 increased contact with infected patients.

70 71 ***Expert Observations from the Town Hall:***

72 73 1. Ultrasound in the diagnosis and monitoring of COVID-19

74
75 In the initial evaluation of a patient with suspected COVID-19, panelists posited
76 that either a completely normal or a completely abnormal lung ultrasound may be helpful.
77 A completely normal examination likely excludes a patient requiring further investigation
78 at that time. Characteristically abnormal findings in a person under investigation for
79 COVID-19 may identify patients requiring further evaluation or closer observation before
80 RT-PCR results return. It is unclear whether B-line or consolidation thresholds exist that
81 predict significant clinical deterioration in well-appearing patients who display lung
82 findings. Observations that ultrasound findings may precede clinical symptoms suggests
83 that ultrasound may identify more severe illness prior to the development of severe
84 symptoms.

85 While lung ultrasound may be of little utility in patients who are critically ill from
86 COVID-19, it may help exclude other pulmonary diseases (including pleural effusion or
87 pneumothorax).⁶ Incorporation of cardiac ultrasound could also identify cardiac
88 complications from COVID-19 and it is recommended that a focused cardiac ultrasound
89 be incorporated into the evaluation of symptomatic COVID-19 patients. Early reports
90 suggest there may be direct cardiac ramifications of COVID-19 including gross LV
91 dysfunction, elevated troponin without ST segment elevation, and potential RV

92 dilation.^{8,9} Additional to lung ultrasound, cardiac views can help identify or exclude
93 cardiac dysfunction and estimate fluid status through evaluation of the inferior vena cava.

94 Critically ill COVID-19 patients may present particular issues with vascular
95 access that ultrasound assists with. Due to respiratory distress, some patients are unable
96 to lie flat, making central venous access difficult. Ultrasound-guided vascular access was
97 found to be quite helpful to establish multiple points of large bore peripheral access, in
98 conjunction with intraosseous lines. Table 1 summarizes the main ultrasound applications
99 used and their associated findings in COVID-19 patients.

100 Future research is needed to clarify the above associations between ultrasound
101 findings and presence of illness, prognostication of illness severity, and ultimate patient
102 outcomes. Panelists emphasized that while ultrasound findings are often characteristic of
103 COVID-19 and may be more prominent in more severe disease, disposition decisions
104 such as admission and level of care would likely be made predominantly on clinical
105 appearance.

106 107 2. Ultrasound equipment

108
109 Newer pocket-carried ultrasound devices using tablet and smartphone technology
110 may be easier to maneuver, protect, and clean after use on COVID-19 patients. It is
111 feasible for the screen to be completely encased in a covering such as a Ziploc bag, and
112 for transducers to be fully enclosed using sheaths. They may be particularly useful in
113 situations where separate care or triage areas for cohorted COVID-19 patients are
114 established outside the main areas where traditional machines reside. Additionally,
115 teleguidance software built into these devices may be useful in providing remote
116 instruction or evaluation of patients who are physically located away from typical
117 treatment areas. Telemedicine and cloud-based image sharing may improve the capacity
118 for care outside the hospital setting, and serial lung exams may provide objective data in
119 remote or virtual clinical decision-making.

120 121 3. Infection control issues

122
123 Aggressive infection control was emphasized by all panelists, as a recent report
124 suggested that the SARS-CoV-2 virus could survive for days on some surfaces.¹⁰ Routine
125 cleaning and disinfection procedures recommended by the Centers for Disease Control
126 are particularly important when procedures with high risk of aerosolization are
127 performed. Prior to entering the room, all unnecessary equipment including extra probes
128 should be removed from the machine to minimize surface exposures. If available,
129 transparent covers for machines and probes can be considered. If resources allow,
130 equipment that is dedicated for use in patients with suspected or confirmed COVID-19
131 may be helpful. The Environmental Protection Agency maintains a list of SARS-CoV-2
132 approved disinfectants ([https://www.epa.gov/pesticide-registration/list-n-disinfectants-
133 use-against-sars-cov-2](https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2)).

134 135 **Conclusion**

136

137 Ultrasound as a diagnostic test presents distinct advantages for imaging in COVID-19. It
138 is a mobile technology that can be used in diverse environments, including in triage tents or
139 makeshift hospitals that are now established for COVID-19 evaluation at many centers. POCUS
140 in particular, where the clinician both performs and interprets the images immediately at the
141 bedside, can minimize involvement of additional personnel in an infectious situation and provide
142 immediate diagnostic information. However, care must be taken to avoid increased transmission
143 of disease.

144 Incorporating ultrasound into the evaluation of COVID-19 patients will depend upon
145 available resources, expertise of personnel, and logistic configurations unique to each situation.
146 Further research and data are needed to determine the role of ultrasound as a screening tool for
147 establishing both admission thresholds and level of care, its use in prognostication and
148 monitoring of inpatients, as well as novel uses like home telemonitoring in discharged patients.
149 Ultrasound appears promising as a first-line and perhaps comprehensive diagnostic imaging
150 modality in suspected or diagnosed COVID-19.

151
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153 American Emergency Medicine, the American Academy of Emergency Medicine, and the
154 Society of Clinical Ultrasound Fellowships for co-hosting this panel.

155
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For Review Only

Table 1: Point-of-Care Ultrasound Applications and Findings in COVID-19 patients

Lung Ultrasound	
<ul style="list-style-type: none"> ○ Panelists used 6-12 zones, or less 	<ul style="list-style-type: none"> ● Thickened, irregular pleural line ● B-lines with prominence in different locations (“patchy” appearance). B-lines are ring down artifacts from interstitial fluid characteristic of pneumonitis. ● Subpleural consolidations ● Larger consolidations
Cardiac Ultrasound	
<ul style="list-style-type: none"> ○ Parasternal long and short axis ○ Apical 4-chamber view ○ Subxiphoid view ○ Subxiphoid long axis (Inferior Vena Cava) view 	<ul style="list-style-type: none"> ● Pericardial effusion ● Depressed ejection fraction or gross LV dysfunction ● RV enlargement & evidence of strain ● Hypo- or hypervolemia
Vascular	
	<ul style="list-style-type: none"> ● Deep venous thrombosis ● Guided peripheral or central access ● Guided arterial lines

NB: Panelists noted that there may be significant difficulties scanning all lung or cardiac views due to patient positioning or comfort, and levels of distress.