Review Article

Use of ultrasonography in COVID-19: Probing for success

Sanchit Kumar[1], Arvind Kumar[1], Pawan Goel[1], Surabhi Vyas[2], Upendra Baitha[1], Naveet Wig[1]

[1]Departments of Medicine and [2]Radiology, AIIMS, Delhi, India

Abstract

The ongoing pandemic of COVID-19 has put an immense strain on healthcare facilities around the world. Unique challenges are being faced in the adequate management of rapidly increasing number of cases while ensuring adequate healthcare providers apostrophe safety. Issues related to the difficulty of examination while wearing personal protective equipment, need for objectivity in triage and testing of patients, and evidence-based management of the critically ill has resulted in reliance on longitudinal radiological assessment. There are a number of portability, disinfection and radiation exposure related problems with the use of X-rays and computerized tomography (CT). Point of care ultrasonography provides a pragmatic, safe, and repeatable approach for addressing the pertinent clinical questions that have traditionally relied on X-rays and CT scans. Here, we summarize the use ultrasound assessment can play in the triage, identification, and subsequent management of patients with COVID-19.

Keywords: COVID-19, SARS-CoV-2, ultrasound, triage

Introduction

The COVID-19 outbreak has quickly evolved into a global pandemic that has left countries around the world battling to contain the spread of this novel coronavirus.[1] In addition to being a significant strain on healthcare resources, the pandemic has given rise to a number of issues pertaining to containment, stratification, testing, and management of affected patients. While global personal protective equipment (PPE) shortages have resulted in guidelines to ensure rational usage, the priority of protecting caregivers has become especially paramount.[2]

Address for correspondence: Dr. Arvind Kumar, Assistant Professor, Department of Medicine, All India institute of Medical Sciences, New Delhi - 110 029, India.
E-mail: Linktoarvind@gmail.com

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Issues with Patient Management

With proper precautions to protect healthcare personnel from the virus, taking care of patients with diagnosed or suspected COVID-19 creates a number of challenges:

- Inadequate clinical examination including auscultation while in PPE
- Maintenance of proper infection control measures while using bedside portable X-rays
- Logistical issues with arranging CT scans for infected/suspected patients
- Adequate utilization and protection of healthcare personnel by minimizing exposure wherever possible (e.g., minimizing aerosol generation, dedicated radiology equipment for COVID areas)

Point of Care Ultrasound (POCUS)

A number of clinical questions that traditionally require X-rays and CT scans can also be answered by using bedside

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ultrasound (USG). Easy availability, accurate and quick result apart from the ability to perform longitudinal assessment at frequent intervals without the use of ionizing radiation makes ultrasound a useful modality for patient management. Both linear and curvilinear probes using B-mode scanning (with or without M mode) and Color Doppler (for deep vein scans) can enable most issues to be addressed using ultrasonography. For these reasons, it becomes important for the first-line clinicians to be aware of the benefits of using POCUS in aiding clinical management. These practical application related aspects as they pertain to the COVID-19 pandemic are being summarized below.

Proposed Utilities

Ultrasound can help in decision making at various levels of patient care—from identification of cause of respiratory distress to nuanced decision making in mechanically ventilated patients. Such uses in the given scenario may include-

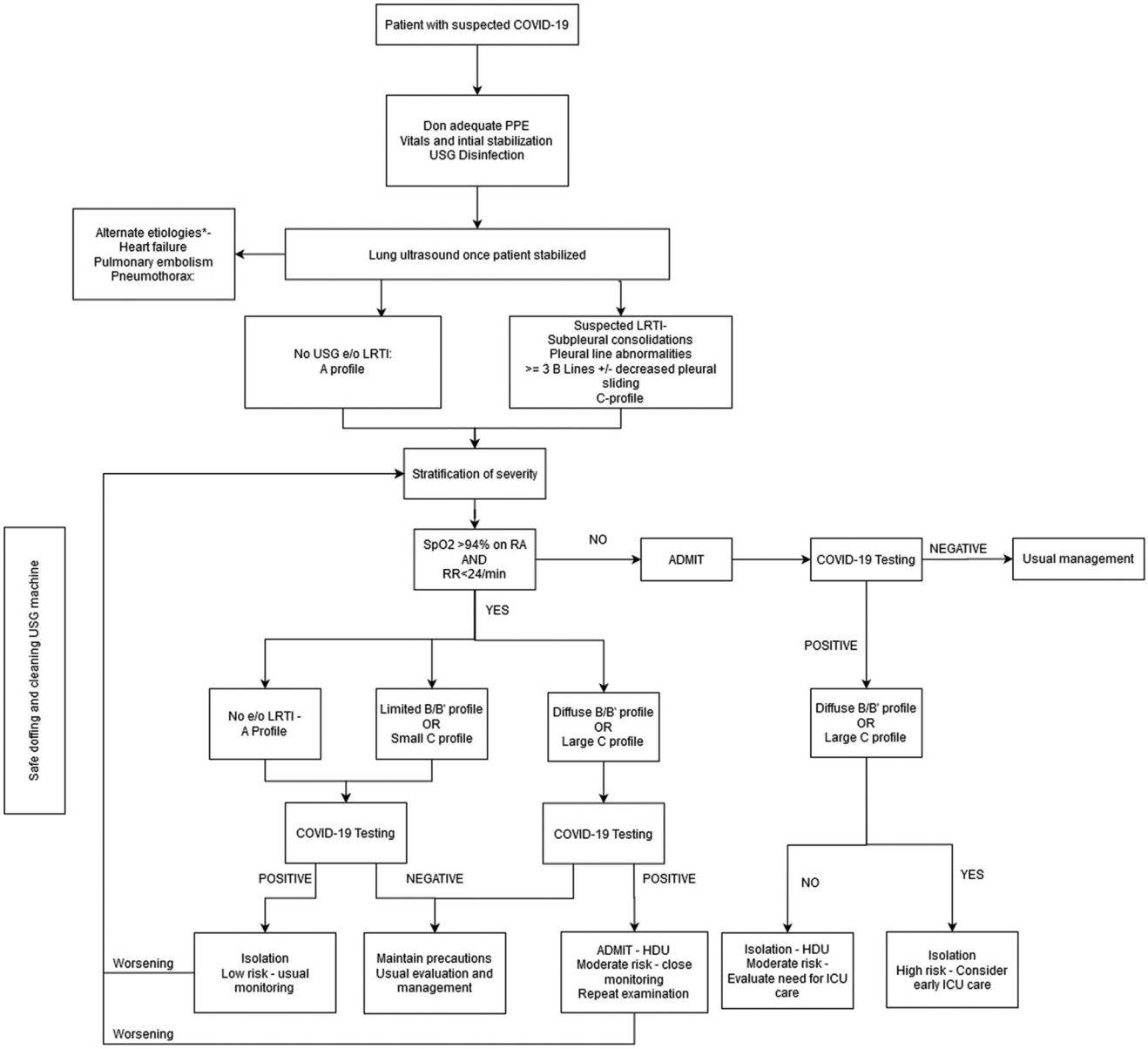
- **Triage of patients:** The portability and increased sensitivity of LUS provides a convenient, objective, and repeatable assessment of the degree of lung involvement, that, along with clinical profiles, could help to triage patients and determine the level of care required. While some algorithms have been proposed, these need to be validated in different settings before more widespread use.[3] One such example is shown in Figure 1**.**
- **Evaluation of severe acute respiratory distress**: After initial assessment of vitals and adequate stabilization, use of the BLUE protocol devised by Lichtenstein *et al.* provides a rapid method of assessment of patients with respiratory distress.[4] As COVID has been seen to involve peripheral and subpleural areas, especially the posterior and inferior regions including lower lobes, it may be prudent to use a more complete evaluation of the thorax, especially scanning the dependent areas adequately with lung ultrasound (LUS) compared to the usual areas defined in the BLUE protocol.[5-9]
- **Diagnosis of COVID-19**: Lung ultrasound is more sensitive than traditional chest X-rays in detecting lower respiratory tract involvement even when used in resource limited settings.[10,11] Use of LUS may therefore provide a more rapid and sensitive method of detecting COVID-19 related pulmonary manifestations. Preliminary LUS findings in COVID-19 include pleural line abnormalities, subpleural consolidations, B-lines including the "waterfall or light beam sign," consolidations (C-profile) and small localized pleural effusions.[5,9,12,13] As more literature is produced, standardized reporting and data acquisition may provide data about findings that may differentiate COVID-19 from other etiologies.[14]
- **Critical care related:**
  - Acute respiratory distress syndrome (ARDS) vs cardiogenic pulmonary edema: Cardiogenic edema with a diffuse B-profile, lack of subpleural consolidation, and absent areas of sparing can be distinguished from ARDS and thereby help guide management of such patients.[15]
  - Confirmation of endotracheal tube position: Direct visualization of the endotracheal tube feedback about adequate tube placement.[16]
  - Assessment of fluid responsiveness: Many critically ill patients develop hypotension and protocols using USG help in predicting the ones likely to respond to intravenous fluids.[17,18]
  - Guided central and arterial lines: Using ultrasonographic guided cannulation and central/arterial line placement results in improved success and reduction of complication.[19,20]
  - Screening for deep vein thromboses: Evidence now exists that COVID-19 is a pro-thrombotic state which may require careful management.[21,22] Bedside ultrasound can help screen for thromboses and improve decision making regarding prophylactic and therapeutic anticoagulation.[23]
  - Assessment of adequate lung recruitment: As the profiles on lung ultrasound extend from a spectrum of air (A-profile) to increasing interstitial and alveolar fluid (increasing number of B-lines) to frank consolidation (C-profile), the properties can be used during recruitment maneuvers to assess their adequacy in recruiting additional alveoli.[24,25]
  - Predicting efficacy of prone positioning: Changes in aeration of dependent areas as assessed by ultrasound can help in predicting patients likely to have good response to proning.[26-28]
  - Weaning from mechanical ventilation: Studies using ultrasound assessment of diaphragm excursion and diaphragm thickness fraction to predict poor weaning outcomes have been shown to have good predictive values and may therefore help in bedside decision making for the same.[29-31]

Infection Control for USG Machines

For all its benefits, ultrasound machines can be a source of infection transmission if not adequately disinfected between patient scans. Infection control guidelines for ultrasound machines have been published but manufacturer specific recommendations[32] regarding compatible agents and regimens must also be reviewed before standardized adoption of these measures for safe and effective operation of these devices.[32-34] These usually include using cleaning solutions followed by disinfection (with sodium hypochlorite). Dedicated machines in COVID/triage areas can further enable safer utilization of ultrasonography in patient management.

Conclusion

Given the constraints in usual patient care and management imposed by the COVID-19 outbreak, bedside ultrasound can serve to provide clinicians fast and accurate diagnostic as well as prognostic information regarding patient status. It can help guide therapy by the assessment of fluid status, guided catheter positioning, evaluation for lung recruitment candidacy,



COVID- Novel SARS CoV-2, HDU: High Dependency Unit, ICU: Intensive Care Unit, LRTI: Lower respiratory tract infection, PPE: Personal protective equipment, RA: Room air, RR: respiratory rate, pO2: Oxygen saturation,
*:
Heart failure- Diffuse B profile, absent areas of sparing, no subpleural consolidation
Pulmonary embolism: A profile, normal lung sliding, deep vein thrombosis +
Pneumothorax- A profile, absent lung sliding, lung point +

Figure 1: Algorithm for use of lung ultrasound for triage of suspected COVID-19 patients

measuring the efficacy of prone ventilation, and prediction of weaning tolerance. Incorporation into institutional protocols and standardized reporting can further enable rapid acquisition of performance data that can serve to further improve patient care. Bedside ultrasonography can therefore be a useful modality in the fight against the COVID-19 pandemic.

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Conflicts of interest

There are no conflicts of interest.

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