

## The Role of Point-of-Care Ultrasound in COVID-19

### A Talk with Italian Critical Care Physician Enrico Storti

Hospitals all over the world are working to rapidly expand their capacity to treat critically ill patients with COVID-19. To find out how hospitals on the frontlines of the pandemic are coping and the lessons learned that could help other hospitals prepare, FUJIFILM SonoSite's Chief Medical Officer, Diku Mandavia interviewed Enrico Storti, the ICU Director/Unit Coordinator of the Emergency Department at Maggiore Hospital in Lodi, Italy, located near Milan, the epicenter of the Italian COVID-19 outbreak.

Dr. Storti's ICU treated what is believed to be Patient One of the Italian outbreak and hundreds of other critically ill COVID-19 patients. In this article, Dr. Storti discusses how his team rapidly transformed their hospital's ICU to deal with an unprecedented "mass casualty event" and the role that point-of-care ultrasound has played in triaging and monitoring patients and providing more efficient care.

***Dr. Mandavia: Let's start with Patient One. How did that individual present to your emergency department [ED]?***

***Dr. Enrico Storti:*** Although our Patient One is the first patient whom we were able to diagnosis as COVID-19 positive, unfortunately now it's a pretty clear that the virus was around the Codogno area for maybe 15 days before that. He was a 38-year-old male with a recent medical history of fever, cough, and flu-related symptoms. He referred to our ED and we proposed hospitalizing him, but he decided to leave. Unfortunately, after 12 hours, he was forced to return. We tried noninvasive mask ventilation, but it was a very short trial because acute respiratory distress syndrome [ARDS] was evident.

What was astonishing was that we tried to assess the patient using our usual protocols, yet we couldn't find a convincing cause of this ARDS. After going deeper into his medical history with his wife, we learned that he had contact with a colleague who had returned from China. We immediately ordered a coronavirus lab determination. The first result came back indeterminate, but a repeat test was positive, so on February 20, we had the first official case of coronavirus in Italy.

***Dr. Mandavia: What happened when you started getting such a number of patients that you were unable to use your usual methods of triage?***

***Dr. Storti:*** Normally in the Lodi hospital, our average number of patients is 150 to 180 per day, many of whom are white codes and green codes, which are the lower gravity codes.

We immediately received 120 red and yellow codes that are the higher codes in terms of triage. So, what was astonishing was the level of gravity of clinical involvement and the waves of patients per day observed. Immediately it was clear that if we decided to use our usual protocols, we couldn't cope.

So, we decided to shift to a mass casualty approach. We decided to use arterial gas analysis, chest x-ray, lung ultrasound, and for the less severe patients, the walking test. Using these four items, we managed to fully triage the patients in a very effective way, without using CT scan. For ARDS, CT scan is the gold standard, but we were seeing 15-25 patients at the same time, and we had no time to manage them with a CT scan.

What is amazing is that lung ultrasound is very close to the CT scan in detecting the lesions of the bilateral lung involvement. In the very few cases that we managed to do both a CT scan and lung ultrasound, there was a very tight correlation in terms of lesions and lung involvement. We clearly understood that ultrasound was the perfect tool, a repeatable, noninvasive, very quick, effective way to address diagnosis of this coronavirus infection.

***Dr. Mandavia: Which ultrasound views do you use during this exam?***

***Dr. Storti:*** The lung ultrasound examination is very quick, starting from the posterior region where it's much easier to find lesions, followed by the bases, and the apex to the base of the lung posteriorly, and the other two windows in the front of the chest, so basically six windows per lung. In two minutes you can perform the lung examination, which is efficient to assess what kind of pneumonitis you have, and if it's monolateral or bilateral, or if you have an ARDS pattern.

***Dr. Mandavia: What are the typical lung findings you see in COVID-19 patients?***

***Dr. Storti:*** Some patients present with a fever and a cough, but are not short of breath. In these cases, with ultrasound you find very small, isolated, lesions bilaterally or even monolaterally. In more severe cases, you have pleural line thickening, which is the main difference between pulmonary edema and lung interstitial syndrome. A normal pleural line is typical of pulmonary edema and not interstitial involvement. In more severe coronavirus cases, you see a thickened, interrupted and irregular pleural line. Starting from this abnormal pleural line, there are isolated B lines or many B lines that become larger and coalesce into a white lung pattern. A completely white lung is a clear sign of extensive lung involvement.

If there is a large inflammation inside the lung, you have consolidation: an area where the lung is completely deflated. This kind of consolidation is located in a subpleural position, maybe very small, centimetric, or pretty large, and that is another sign of lung involvement.

It's not common to see pleural effusion in coronavirus. What is a clear sign of ARDS or severe inflammation of damaged lung are the spared areas, where lung ultrasound detects a portion of sick lung aside a normal lung. Spared areas are another indication of alveoli interstitial syndrome.

***Dr. Mandavia: Did you use point-of-care ultrasound in other ways?***

***Dr. Storti:*** The innovative idea has been to use lung ultrasound along all the patient pathways, starting from the pre-hospital emergency services, reaching the hospital in the triage area, following the patient in the shock room or in the other sectors in our ED, reaching the different wards, ending in the stepdown units and the ICU.

The problem is when you receive patients that are in the middle, so they are not a mild lung involvement, yet at the moment, not an ICU case, but with huge potential for worsening. In these patients, ultrasound is the perfect tool to assess the patient with serial examinations to find out if the patient is worsening. We also scan the inferior vena cava in order to assess the fluid volume, but also as an indirect sign of cardiac performance.

If the right ventricle is enlarging, the inferior vena cava is not collapsible, and arterial blood gas analysis or other blood tests are worsening, putting together these items, you have to be ready to rapidly adapt your clinical strategy and to address the patient with the correct level of care in your hospital, as a sort of field triage, even if the lung findings are unchanged.

***Dr. Mandavia: What other steps did you take to transform your hospital?***

***Dr. Storti:*** We have created a stepdown unit from scratch that went from zero four to 18 beds and tripled the number of ICU beds from seven to 25. We also completely changed physicians' jobs. About 30 percent of my team of 21 ICU physicians are out with coronavirus, so anyone who is a physician and can give us a hand with ventilation—emergency physicians, pulmonologists, surgeons and internists—has been redeployed within the hospital. This is not perfect, but the standard of care we have managed to accomplish has been sufficient to cope with the situation we are forced to face.

***Dr. Mandavia: What are the lessons learned?***

***Dr. Storti:*** If you receive, as we did, a huge number of ICU patients at the same time, you cannot cope using the same protocols we use in the peace period. You have to reinvent, to reshape and to reconsider your protocols. You may have no time for the gold standard. Around us in the Lombardy region, we have a bigger hospital compared with mine, they made different choices—and collapsed in two days. So, if you wait for a CT scan, you wait

for swab determination, and you wait two or three days for test results before moving the patient because you wish to be very secure that it is positive, on day three, you have five or four hundred patients in the emergency department. I have to admit that using our protocol, we managed to properly manage patients, sending them in positive/negative wards with very high accuracy

Luckily, we brought point-of-care ultrasound in, starting in 2007 in Lodi. So, wherever you go, there is an ultrasound machine, and ICU physicians and nurses are well-trained in using point-of-care ultrasound. This has been really crucial during this mass casualty situation, because we talk the same language, we use the same paradigms and we can use the same way of thinking. So wherever the patient goes, there are physicians who are able to perform a comprehensive point-of-care ultrasound examination.

I would like to acknowledge Stefano Paglia, the director of our emergency department. We have been working for 10 years sharing this amazing story with point-of-care ultrasound. He has been the real energy in the emergency department in spreading the message that ultrasound has a huge impact. That made it easier in the very beginning with this epidemic outbreak in our hospital to use ultrasound.

***Dr. Mandavia: What was Patient One's ultimate outcome?***

***Dr. Storti:*** For two days, we managed him with the standard of care, including internal pulmonary ventilation and prone/supine strategy, which are the pillars for ARDS. Then we became concerned that he might need ECMO [extracorporeal membrane oxygenation] treatment, which was not possible in Lodi. We transferred him to a large regional hospital in Pavia. The regional hospital congratulated us for our management of him during the first 48 hours and they were able to treat him with standard protocols without ECMO strategy. What is important is that a week ago, he was discharged to home—and so is finally one of the first in Italy who managed to fully recover.

During those first few days, we received a number of patients who should have been intubated, but we didn't have enough ICU beds or ventilators, so we were forced to use noninvasive masked ventilation. We managed to gain enough time with this ventilatory modality to triple the number of ICU beds available, collect ventilators from all of the hospital and transform our hospital's ability to help patients recover.

We also transferred a lot of patients in the very beginning. Later on it was not possible because all the region has the same problems we have and the hospitals are completely overwhelmed. In five weeks, we increased our number of ICU beds threefold, and this effort has been duplicated by other colleagues in the other hospitals. In this mass

casualty situation, I have managed to survive and to save some patients. That is a huge reward—and the reason why I became an intensivist.

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