

Case Study

Healthcare
Medical Imaging



AI-Based Ultrasound Supports Assessment and Treatment Management of COVID-19 Patients

GE Healthcare teams with Intel to offer powerful imaging technology

“I joke with medical students and residents that although we carry a stethoscope, anything I really want to find out, I can see with an ultrasound.”

— Dr. Brian Boer, University of Nebraska Medical Center (UNMC)

Ultrasonography has come a long way since its discovery by Italian biologist Lazzaro Spallanzani in 1794. First used in hospitals starting in the 1950s, ultrasound quickly became indispensable, most notably in helping doctors and expectant parents view a fetus in utero. In recent years, clinicians have explored novel uses for the technology to address a growing list of critical medical needs, including in the triage and treatment of patients suffering from COVID-19.

As ultrasound applications have grown, users have turned to manufacturers for updates to the instrument's size and capabilities, requesting greater mobility, faster operation, and a more seamless design for easier cleaning. The introduction of artificial intelligence (AI) has further accelerated the transformation, empowering the healthcare industry to dramatically rethink the use of ultrasound and the workflows supporting it.

GE Healthcare, a longtime industry innovator, has helped drive that evolution and is now drawing on its expertise to assist healthcare workers as they address the urgent needs around the global coronavirus pandemic. As emergency rooms (ERs) and intensive care units (ICUs) struggle to keep up with the virus's spread, clinicians are turning to GE Healthcare ultrasound as an effective diagnostic tool that obtains images more quickly than traditional computed tomography (CT). CTs require a longer scan time and transport of patients, which can create more risk for contagion in the COVID-19 environment and unwanted exposure to ionizing radiation, especially in pediatric and pregnant patients.

Research has shown that ultrasound can be as good as a chest CT for monitoring patients with COVID-19.¹ Some studies have demonstrated that signs and symptoms in the lungs of COVID-19 patients can be seen on ultrasound before an X-ray.¹ This benefit is credited to the tool being better at seeing the surface of the lung where the virus lives. The addition of AI into recent generations of ultrasound is further distinguishing the technology from other medical imaging solutions.

“The ultrasound is a really versatile tool because it has the capabilities of what would normally require multiple different modalities, providers, tools, or imaging,” said Dr. Brian Boer, a critical care and pulmonary disease physician at the University of Nebraska Medical Center (UNMC). “With an ultrasound, you can consolidate it all down into one person running one machine. I joke with medical students and residents that although we carry a stethoscope, anything I really want to find out, I can see with an ultrasound.”

An advocate of the ultrasound as a versatile diagnostic tool, Dr. Boer has taught its use and relied on the device for nearly a decade. Most recently, he was part of the US team tasked with treating the first wave of COVID-19 patients at the UNMC's Nebraska Biocontainment Unit (NBU). Commissioned in 2005 by the US's Centers for Disease Control and Prevention (CDC), the NBU is one of only a few biocontainment units in the country. It is also the largest, providing the first line of treatment for people affected by bioterrorism or highly hazardous communicable diseases like COVID-19.

Demand for GE Healthcare's Point-of-Care Ultrasound Surges

Designed in collaboration with former software-engineer-turned-ER physician, Sohan Parekh, the AI-based Venue family (Venue and Venue Go) of ultrasound systems is helping to shift the operational standard for medical imaging used by busy ER, ICU, and Anesthesiology units.

The Venue family is designed specifically for the point-of-care environment. It includes features like a large, flexible touchscreen monitor and an up to two- (in Venue Go) or four-hour scan-time battery and probe placement up top to keep cables out of the way. Venue Go offers additional flexibility with an adaptable design that goes from cart to table to wall. And, both Venue family products feature high image quality, AI technology, and easy cleanability with touch-screen surfaces.

"When COVID-19 hit, there were tons more patients, so hospitals started to get congested and there was an ongoing challenge with cleaning and infection," said Anders Wold, president and CEO of Ultrasound at GE Healthcare. "The result is you need to bring the equipment to the patient. That's been enormously helpful and simplified things. This has triggered a huge surge in orders for point-of-care ultrasound and for the Venue family product line, which is extremely well tailored to current needs."

Due to uncertainties related to the virus's transmissibility, sanitization quickly became a vital consideration as hospitals sought to protect healthcare professionals and the public. Venue and Venue Go have become important frontline tools during the COVID-19 crisis due to the fact that they offer a slick, tablet-like design that makes them easier and faster to clean and sanitize.

"It's difficult and time-consuming to travel outside of the room to the CT scanner because of the steps necessary to prevent the fear of spreading the virus. So we're often relying on the ultrasound for any advanced imaging beyond the X-ray," said Dr. Boer. "All of a sudden, the ultrasound has become the ultimate tool, which it always kind of has been for us in critical care. I went to our executives and said that if they wanted us to respond to the pandemic, we need ultrasounds for every ICU. We were immediately able to get the Venue for our newly created COVID unit."

The devices also offer an intuitive, easy-to-use interface. This permits new users to ramp up quickly and confidently, which was especially important during the first months of COVID-19 when speed and efficiency were critical as ERs and ICUs filled with sick patients. In Wuhan, China, clinicians reported that the Venue touchscreen allowed them to operate the device while wearing three layers of gloves, the accepted safety protocol early in the pandemic.²

AI Brings New Capabilities to Ultrasound

The Venue products represent the first family of AI-enabled POCUS systems built on a common software platform. Portable for use in a variety of settings, the devices equip clinicians to quickly access important health data and monitor patients without the need for a daily X-ray or CT scan, thereby reducing the need for ionizing radiation.

The introduction of AI enables the Venue family of products to automate a range of protocols, measurements, and calculations, empowering clinicians to move faster and keep track of patient health trends over time. Key indicators can be identified quickly, accelerating triaging decisions, reducing operator fatigue and error, and increasing reproducibility.

An inferior vena cava, or IVC, evaluation is just one example. The Venue family's Auto IVC Tool enables the user to assess if there is enough fluid in a patient's body. The doctor merely needs to obtain the right image and hit a button to secure a measurement. Though it is possible to conduct this step manually, the process takes time and effort for setup and is often skipped as a result, denying the treatment team potentially valuable diagnostic information.

The Venue family's Auto B-lines tool is able to highlight and count B-lines in one step and do it in real time. Ultrasonographic B-lines are long beams of hyperechoic

artifacts that traverse the entire ultrasound screen vertically, often seen in patients with pneumonia and pulmonary consolidation, which occurs when lung tissue fills with liquid instead of air.

"We know a person has a high likelihood of COVID positivity if they have a fever and other symptoms and they have ground-glass infiltrates on CT," said Dr. Boer. "We also know that the corollary to those infiltrates is B-lines on the ultrasound exam. So if we're seeing diffused B-line patterns and other characteristic COVID symptoms, then patients are tested for COVID. The ultrasound gives us that added layer of diagnostic help."

At the same time, crisper imagery means an enhanced ability to detect irregularities and giveaway patterns in grayscale while assessing cardiac, lung, and vascular conditions. The need for multiple manual measurements is removed as is the time-consuming step of scrolling through previously collected images.

The automated calculations provided by the Venue family of products also deliver a quick cardiac assessment, a critical function given that research has identified an important connection between COVID-19 and complications in the heart, especially the right ventricle.

GE Healthcare's Vivid Ultra Edition Ultrasound Examines COVID's Cardiac Impacts

Several next-generation AI capabilities have also been designed into GE Healthcare's Vivid Ultra Edition ultrasound product line. According to GE Healthcare, AI tools help minimize human error, operator fatigue, and cardiac examination time while boosting reproducibility. All have proven invaluable benefits as doctors seek to understand the connection between COVID-19 and cardiac complications.

Early in the virus outbreak, clinicians in China reported signs of myocarditis and heart disease associated with the COVID-19 patients they were seeing. Linked to higher mortality, myocarditis causes an inflammation of the heart muscle that enlarges and weakens the heart, forcing it to work harder to circulate blood and oxygen throughout the body. Italian doctors identified the relationship as well, acknowledging a spike in out-of-hospital cardiac arrests among COVID-19 patients.

Doctors point to an enlargement of the heart's four chambers as a possible predictor of which patients with severe COVID-19 infections are most likely to die. More specifically, as noted earlier, doctors and researchers have observed a particular connection between COVID-19 and strain on the heart's right ventricle.³

Clinicians rely on the mobile, robust, easy-to-use Vivid Ultra Edition ultrasound systems to assess the left ventricle as well as the right ventricle, widely regarded as one of the most challenging tasks in echocardiography. Cardiovascular ultrasounds like the Vivid Ultra Edition equip medical personnel to see the changes occurring in the right ventricle in ways that other modalities simply cannot, making it an important tool during diagnosis, recovery, and beyond.

The Vivid Ultra Edition offers an intuitive workflow and the versatility to scan patients with COVID-19 in environments as diverse as the bedside, echocardiography and catheterization labs. It can be ready for bedside scans in less than five seconds, speeding the delivery of vital health information and helping the user determine if the heart is pumping enough blood through the primary arteries to the organs.² By returning data quickly, it also minimizes contact time with infectious patients.

Healthcare continues to explore this growing concern regarding the long-term cardiac impact on COVID-19 patients. Such an investigation makes tools like the Vivid Ultra Edition ultrasound systems unusually critical as a means for measuring the function of the myocardium to combat dangerous potential effects of COVID-19, including myocardial edema, fibrosis, and other cardiac function impairments.

GE Healthcare Collaborates with Intel to Help Advance Precision Health

As GE Healthcare designed and developed its ultrasound Venue and Vivid Ultra Edition product lines, it collaborated with Intel, a trusted partner of more than 15 years. The relationship is built on the companies' shared commitment to precision health and improved patient outcomes. To achieve those goals, both seek to harness the power of technology by provisioning the right hardware for the right workload, lowering costs without compromising performance.

Intel technology provides a fast, more secure, and reliable path forward for GE Healthcare innovation. For example, as the Venue family incorporated new AI tools, the system required additional processing power and capabilities. GE Healthcare leveraged Intel® Core™ processors on Venue to meet the computational needs and used the Intel® Distribution of the OpenVINO™ toolkit to quickly meet the AI applications' performance requirements during development of Vivid Ultra Edition features.

Intel technology also helped GE Healthcare meet low-power, battery, and image-quality demands for its point-of-care devices.

With the Venue Go product, Intel helped GE Healthcare shrink the Venue tower-based system into a full, compact, tablet-based solution, doing so without undermining the device's requisite performance or reliability. These efforts helped the GE Healthcare Venue family of POCUS products earn several recent design awards, including from [IDSA](#), [Good Design Australia](#), and [UX](#).

"A long time back we started our relationship with Intel," said Wold. "Our needs may be different from other industries, but we have seen that the teams we're working with at Intel have learned a lot about what we want to do, and they have changed their architecture accordingly. We've experienced a lot of cooperation at the engineering level as well, making for a very good mutual benefit and a very fruitful partnership."



GE Healthcare Ultrasound Product Lines Deliver Results

The onset of the global coronavirus pandemic has sharpened the need for GE Healthcare's ultrasound diagnostic tools. Since the start of the outbreak in China, clinicians have increasingly turned to the Venue family and its AI tools to deliver fast patient information, particularly in the ICU and emergency departments. Users in a GE internal study experienced an up to 82 percent time savings by using the Auto VTI tool on a GE Healthcare Venue Go.⁴ This time savings has the potential to enable users to move more quickly on a treatment pathway.

The Venue family's innovative design contributes to the time savings while lowering transmission risk due to the devices' cleanability, portability, and long battery life. As a result, GE Healthcare has received unprecedented interest in its ultrasound systems worldwide. Demand in Europe has been particularly high, with many European clinicians relying on the Venue POCUS for its excellent accessibility and cleanability.

In a GE Healthcare internal study, users experienced an up to 82 percent time savings by using an Auto VTI compared to a manual method.⁴

Clinician feedback drives ultrasound evolution

Because of the impacts of COVID-19, the virus has accelerated the adoption of Venue and Vivid Ultra Edition product lines into healthcare workflows. As the pandemic continues to impact communities around the world, these versatile devices have become must-haves for doctors and clinicians. The interest in and commitment to the benefits of POCUS and echocardiography are only expected to grow.

"It wasn't that long ago that, reputationally, ultrasound trailed behind some of the other imaging modalities on the market," said Wold. "Today, it has become a preeminent imaging modality and I don't see much limit to that because it's mobile, inexpensive, simple to use, and you can make quick decisions. And now AI is just going to bring it to the next level."

GE Healthcare is proud to be among the leaders helping evolve and expand the role of the ultrasound. The company's vision is to continue to work with partners from healthcare and technology, such as Intel, to refine and improve its ultrasound systems. In this way, GE Healthcare aims to develop still-smaller, more-portable solutions and equip next-generation systems with higher-quality images able to provide doctors with an even more detailed picture of the heart and lungs.

That goal is now inextricably linked to an ongoing exploration of appropriate deep learning-based AI tools and 3D visualization. By incorporating AI to automate time-consuming manual functions, users and the patients they serve will receive faster, more detailed insights to support improved decision-making. Like GE Healthcare, Intel is committed to improving diagnostic tools like ultrasound, focusing its industry-leading expertise on finding new and creative solutions that marshal the power of technology to drive health benefits across the planet.

For GE Healthcare, it all starts with listening to today's busy healthcare providers. Only then can it design and develop the tools that will successfully meet the operational needs of clinicians and contribute to better patient outcomes and a healthier world.

Learn more about GE Healthcare and Intel

Read more about GE Healthcare and its innovative ultrasound product lines at gehealthcare.com/corporate/ultrasound-covid-19.

For more information about healthcare and life sciences technology solutions powered by Intel, visit intel.com/healthcare.



1. Young-Jae Cho1*, Kyoung-Ho Song2*, Yunghee Lee1, Joo Heung Yoon3, Ji Young Park4,5, Jongtak Jung2, Sung Yoon Lim1, Hyunju Lee5, Ho Il Yoon1, Kyoung Un Park6, Hong Bin Kim2, and Eu Suk Kim2, "Lung ultrasound for early diagnosis and severity assessment of pneumonia in patients with coronavirus disease 2019," Korean J Intern Med 2020;35:771-78.

2. Data provided by GE Healthcare

3. Tomasz J. Guzik, et. al., "COVID-19 and the cardiovascular system: implications for risk assessment, diagnosis, and treatment options," Oxford University Press, April 30, 2020.

4. Based on an GE internal study performed in March 2019 by experts using Venue Go, DOC2254811.

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