



Ultrasound is not dead, it's immortal!

Jiro Hata¹

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Ultrasound (US) as a morphological diagnostic modality is widely used around the world, but there seems to be differences between regions and institutions with respect to the degree to which it is utilized and contributes to determining treatment strategies. In Japan, in particular, which is one of the top countries in the world in terms of the number of computed tomography (CT) units in use per capita and the number of tests performed (source: OECD.Stat, <https://stats.oecd.org/>), the dependency on CT in routine clinical practice is high, and I often feel like US is relegated to a simple screening method or treated as an examination that can be omitted when I listen to presentations at conferences other than those held by The Japan Society of Ultrasonics in Medicine (JSUM). Moreover, the number of young doctors joining JSUM has not been that high in recent years, which makes me slightly anxious about the future. Is US destined to fade away eventually? There is no getting around the fact that things that are no longer needed fade away, and the tide cannot be stemmed. Thus, I would like to think once more about the reason for the existence of US in this message.

Like the constant improvements being made in the performance of CT and magnetic resonance imaging (MRI), US technology has advanced to a point that was unimaginable at one time. Moreover, US applications and its reason for existence have become more diverse, as described below, and operators and the required performance differ depending on the situation in which it is used.

1. Point-of-care ultrasound (POCUS): this form of US, which is performed to handily ascertain the background pathology in response to a sign such as shock and rapidly determine a treatment strategy, is a concept that has been widely adopted internationally [1]. Given that it is ordinarily performed at the bedside in a short period

of time, it does not require a very high resolution; on the contrary, many small and lightweight US devices have been marketed as device portability is important. Meanwhile, POCUS has a wide range of purposes, such as triage in the emergency room, follow-up observation of inpatients, and emergency medical care in a setting outside a hospital. One could say that there are as many types of POCUS as there are settings. Therefore, one needs to choose a device suitable for each situation and purpose, balancing the trade-off between device performance and portability. Moreover, the significance of home medical care has been recognized anew as a result of the COVID-19 pandemic, and there may come a time in the future when the patient performs POCUS as a form of remote monitoring, with the doctor determining a treatment strategy after viewing the images sent in. In any event, it is difficult to conceive of the emergence of a diagnostic imaging modality to replace POCUS in the near future given the noninvasivity, convenience, immediacy, and low cost of US.

2. Disease screening: this form of US, the purpose of which is to screen for the presence or absence of an underlying disease in response to a certain sign or laboratory abnormality, is performed at many medical institutions. For instance, evaluation of the biliary system and pancreas in a patient with elevated CA19-9 falls into this category. Cancer screening of asymptomatic patients and other screening also fall into this category [2]. Here, it is treated as a modality to screen for the presence or absence of abnormalities in organs and determine whether further diagnostic imaging is indicated, rather than as a modality for making a final diagnosis. Therefore, a high-end device does not necessarily need to be used, but a certain degree of image quality and performance is required, so portability is not a major concern. Other examinations such as CT are given priority when the sensitivity and specificity of US diagnosis are low; therefore, future challenges include how to minimize the effects of operator skill and examinee body type on diagnostic performance and how to guarantee objectiv-

✉ Jiro Hata
ultrajiro@nifty.com

¹ Department of Clinical Pathology and Laboratory Medicine, Kawasaki Medical School, Okayama, Japan

ity, which is a shortcoming of US. Despite such issues, it will likely continue to have value as a modality with no alternative at facilities without CT and MRI such as private clinics. In addition, its indicated organs and intended purpose may continue to expand, changing the diagnosis and treatment system in each department, such as its rapid adoption in the field of orthopedic surgery for evaluation of soft tissue that cannot be visualized on routine X-ray and as a guide during hydrorelease.

3. **Chronic disease screening:** this form of US, the purpose of which is to monitor the condition of organs over time to aid the treatment strategy (e.g., monitor the liver for chronic liver disease), is currently performed at many institutions. There is a wide range of target organs, and it is now widely used to evaluate the synovial membrane in patients with rheumatism thanks to the increased performance of US devices. It has also gained attention in recent years as a monitoring technique for gastrointestinal tract lesions in so-called inflammatory bowel disease (IBD) such as ulcerative colitis and Crohn's diseases [3]. Strictly speaking, it is difficult to compare US images between different individuals as the images are affected by the pathway of the transmit and receive beams, but since the impact is minimal if the same patient is monitored at the same site, it may be possible to monitor pathological changes relatively accurately. The lack of high tissue resolution available with CT and MRI had also been a shortcoming of US, but it is now possible to observe the detailed properties of lesions that do not appear on the morphology on US by means of real-time evaluation of fine blood flow using superb microvascular imaging (SMI) [4] and by evaluating elasticity using shear wave elastography (SWE) [5]. US, with its superior convenience and noninvasivity, as well as its low cost, is expected to be utilized further going forward for monitoring of organs that present a clear target.
4. **Precision diagnosis:** in this message, I would most like to emphasize the value of this form of US, the purpose of which is to get closer to making the final diagnosis by utilizing the high spatial and temporal resolution of US and the above-mentioned new techniques to ascertain tissue properties. Even if CT has already been performed, US is actually performed at my institution to confirm the diagnosis or to make the final diagnosis in cases where the CT diagnosis is not definitive. This also applies to acute abdomen, where which examination is performed first depends on the situation, but US is never omitted when determining the treatment strategy. The diagnostic ability of US must be superior to that of CT, or US must provide information that CT cannot, to foster such a culture, and it is a self-evident truth that US

will be omitted if its diagnostic ability is always below that of CT. Its high spatial resolution, in particular, is a major advantage of US. Probes with a center frequency exceeding 30 MHz have become available in recent years, with superficial US, in particular, being rated highly for its usefulness [6]. Contrast-enhanced US also provides many findings, capitalizing on the fact that the contrast agent does not migrate to interstitial tissue and that blood flow at the capillary level can be evaluated in real time⁷. There are currently no other modalities that can serve as a substitute for these strengths of US; therefore, the value of US as a modality for precision diagnosis will likely increase further in the future with the accumulation of further findings and improvements in US equipment.

Conclusion

The applications of US are becoming more diverse, and there are no alternative methods for any of them; therefore, it will likely continue to occupy an important position in medical care going forward. Academic societies should widely convey the usefulness and appeal of US to healthcare professionals and provide the education necessary to master it. US is not dead, it's immortal!

References

1. Díaz-Gómez JL, Mayo PH, Koenig SJ. Point-of-care ultrasonography. *N Engl J Med*. 2021;385:1593–602.
2. Butler RS, Hooley RJ. Screening breast ultrasound: update after 10 years of breast density notification laws. *AJR*. 2020;214:1424–35.
3. Hata J, Imamura H. The use of transabdominal ultrasound in inflammatory bowel disease. *Korean J Radiol*. 2022;23:308–21.
4. Jiang Z-Z, Huang Y-H, Shen H-L, et al. Clinical applications of superb microvascular imaging in the liver, breast, thyroid, skeletal muscle, and carotid plaques. *J Ultrasound Med*. 2019;38:2811–20.
5. Nakano C, Nishimura T, Tada T, et al. Severity of liver fibrosis using shear wave elastography is influenced by hepatic necroinflammation in chronic hepatitis patients, but not in cirrhotic patients. *Hepatol Res*. 2021;51:436–44.
6. Bhatta AK, Keyal U, Liu Y. Application of high frequency ultrasound in dermatology. *Discov Med*. 2018;26:237–42.
7. Imamura H, Hata J, Takata T. Contrast-enhanced ultrasonographic findings of non-occlusive mesenteric ischemia: a case series. *Abdom Radiol*. 2021. <https://doi.org/10.1007/s00261-021-03002-1> (Epub ahead of print).

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